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# China Report

SCIENCE AND TECHNOLOGY

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4 September 1985

# CHINA REPORT

## SCIENCE AND TECHNOLOGY

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APPLIED SCIENCES

INVESTIGATION ON ROLLING PRESSURE ON METALLIC URANIUM ROD

Beijing HE KEXUE YU GONGCHENG [CHINESE JOURNAL OF NUCLEAR SCIENCE AND ENGINEERING] in Chinese Vol 4 No 2, Jun 84 pp 136-142

[Article by Zhang Meng [1728 3718] of the Ministry of Nuclear Industry]

[Text] Abstract: The rolling pressure on metallic uranium rod was investigated. By considering the behavior of the uranium metal in a rolling mill as a viscous flow, the differential equation for the rolling pressure was established. A formula for calculating the rolling pressure was derived and the theoretical calculation method was given. The rolling pressure, the coefficient of contact friction, and the lateral expansion of uranium rod were measured. The measured rolling pressure was compared to the calculated value. Rolling is an important forming technique for uranium. A study of the rolling parameters of uranium serves as a basis for rolling mill design, engineering calculation, and rolling mill strength calibration.

I. Theoretical Calculation of Rolling Pressure

The total rolling pressure  $P_t$  is given by

$$P_t = F \times \bar{p} / 1000 \quad (1)$$

where  $F$  is the projected area of the contact surface in  $\text{mm}^2$ ,  $\bar{p}$  is the average pressure ( $\text{kg}/\text{mm}^2$ ) on the projected area, given by

$$\bar{p} = n_v n_\sigma \times 2 K \quad (2)$$

where  $n_v$  is the deformation velocity coefficient<sup>1</sup>,  $n_\sigma$  is the stress state coefficient,  $K$  is the thermodynamic plastic deformation resistance for pure shear and is equal to  $\beta \sigma_s n_H / 2$ ,  $\beta$  is the response coefficient<sup>2</sup> of the second principal stress and is equal to  $1 \sim 1.155$ ,  $\sigma_s$  is the yield limit, and  $n_H$  is the hardening coefficient,  $n_H = 1$  when the temperature is above the recrystallization temperature.

### 1.1 Differential equation of the contact surface pressure

The (Ka-er-man) theory and the (Ao-luo-wen) theory provide differential equations for the pressure in a rolling deformed region. The former is valid for the rolling of thin plates with a contact friction coefficient  $\mu \leq 0.12$  (i.e., the (Li-ke-fu) solution). The range of applicability of the latter depends on the assumptions made. Using the Ao-luo-wen formula, the calculated results are accurate only when  $\mu \leq 0.4$ .

Recently the motion of the metal in a rolling mill has been regarded as a viscous flow and the differential equation for the surface contact pressure was established.<sup>3</sup> However, the equation ignores the effects of the perpendicular component of the velocity. In this paper, we take the perpendicular velocity into account and investigate the solution of the differential equation for the contact surface pressure.

When the plastic zone penetrates the rolling part, the motion of the metal may be approximated with a viscous fluid. Due to the nonuniformity of the motion, shear stress  $\tau_{xy}$  develops in the interior. According to the theory of fluid mechanics,<sup>3</sup> the shear stress is

$$\tau_{xy} = \eta \left( \frac{\partial v_x}{\partial y} + \frac{\partial v_y}{\partial x} \right) \quad (3)$$

where  $\eta$  is the viscosity coefficient,  $v_x$  and  $v_y$  are respectively the horizontal and the vertical components of the velocity of the metal.

$v_x$  in the rolled part has an approximately parabolic distribution with respect to the height<sup>3</sup>:

$$v_x = v_0 (v_{nx} - v_0) y^2 / y_n^2 \quad (4)$$

Figure 1 shows that the  $v_{nx} = v_n \cos \alpha_x$ . Since the intrusion angle is less than  $30^\circ$ ,  $\cos \alpha_x$  is taken to be 1 and we have

$$\frac{\partial v_x}{\partial y} = \frac{2(v_n - v_0)}{y_n^2} y \quad (5)$$

Neglecting the effects of front glide and back glide on the velocity, the surface of the deformed zone has a linear distribution in the length direction of the part. Thus,

$$v_y = v_{ny} x / L$$

where

$$L = \sqrt{R(H-h) - \frac{1}{4}(H-h)^2}$$

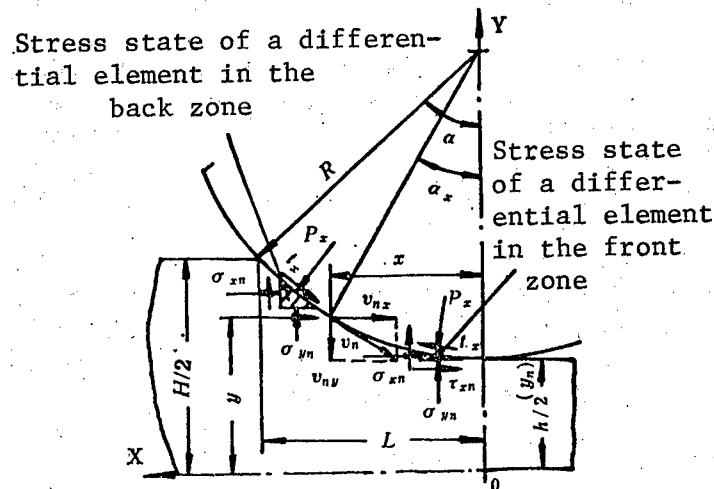


Figure 1. Metal Flow in the Deformed Zone

From Figure 1,  $v_{ny} = v_n \sin \alpha_x = v_n \frac{x}{R}$ . Substituting into the equation above and differentiating, we have

$$\frac{\partial v_y}{\partial x} = 2 v_n \frac{x}{RL} \quad (6)$$

Substituting (5) and (6) into (3) and invoking the boundary condition of the deformed zone, we have

$$\tau_{xy} = \frac{2\tau_{xn}}{h} y - \frac{\tau_{xn}}{\lambda L} x \quad (7)$$

where  $\lambda = h/H$  is the press-down coefficient.

Assuming that rolling causes a planar deformation<sup>2</sup> and substituting (7) into the equilibrium equation and the plasticity equation<sup>2</sup> for planar deformation, one obtains the differential equation for the contact surface pressure by solving the equations simultaneously:

$$\frac{dp_x}{dx} - \frac{2d\sqrt{K^2 - t_x^2}}{dx} \pm \frac{2t_x}{h} \left(1 - \frac{hx}{2\lambda LR}\right) = 0 \quad (8)$$

In Equation (8), the "-" sign is for the front glide zone and the "+" sign is for the back glide zone.

## 1.2 Stress state coefficient $n_\sigma$

Neglecting  $n_v$ , Equation (2) leads to  $n_\sigma = \frac{p}{2K}$ . For simplicity, we take the contact friction to be a constant  $t_x = mK$ , where  $m$  is the frictional factor for plastic deformation. Equation (8) then simplifies to

$$\frac{dp_x}{dx} \pm \frac{2mK}{h} \left( 1 - \frac{hx}{2\lambda RL} \right) = 0 \quad (9)$$

$$P_x = \mp \frac{2mK}{h} \left( x - \frac{hx^2}{4\lambda RL} \right) + C$$

For the back glide zone, we take the "-" sign and  $P_x = P_0$  at  $x = L$ , thus,

$$P_x = P_0 + \left( \frac{2mK}{h} - \frac{mK}{2\lambda L} \right) L - \frac{2mK}{h} x + \frac{mK}{2\lambda RL} x^2 \quad (10)$$

For the front glide zone, we take the "+" sign and  $P_x = P_1$  at  $x = 0$ , thus,

$$P_x = P_1 + \frac{2mK}{h} x - \frac{mK}{2\lambda LR} x^2 \quad (11)$$

The average pressures at the back glide zone and the front glide zone are obtained respectively by integrating Equations (10) and (11);

$$\bar{P}_{back} = \frac{1}{L-L_1} \int_{L_1}^L \left[ P_0 + \left( \frac{2mK}{h} - \frac{mK}{2\lambda L} \right) L - \frac{2mK}{h} x + \frac{mK}{2\lambda RL} x^2 \right] dx \quad (12)$$

$$\bar{P}_{front} = \frac{1}{L_1} \int_0^{L_1} \left( P_1 + \frac{2mK}{h} x - \frac{mK}{2\lambda LR} x^2 \right) dx \quad (13)$$

Because

$$n_o = \frac{\bar{P}}{2K} = \frac{1}{2K} \cdot \frac{\bar{P}_{back} + \bar{P}_{front}}{2} \quad (14)$$

$n_o$  is obtained by integrating (12) and (13) and substituting into (14):

$$n_o = \frac{P_0 + P_1}{4K} + \frac{mL}{4h} - \frac{mL}{24\lambda R} \left( 2 - \frac{\sin \gamma}{\sin \alpha} \right) \quad (15)$$

where  $L_1$  is the length of the front glide zone.  $L_1 = R \sin \gamma$ ,  $\gamma$  is the neutral angle.

### 1. Neutral plane and neutral angle

The interface dividing the front glide zone and the back glide zone is the neutral plane. On this plane the pressures of the two zones are equal and the contact friction changes sign. Substituting  $x = L_1$  into (10) and (11) and set them equal, we have

$$\frac{\sin \gamma}{\sin \alpha} = \frac{2R}{H} - \sqrt{\left( \frac{2R}{H} \right)^2 - \frac{\lambda R(P_0 - P_1)}{mK} - \frac{2R}{H} + \frac{1}{2}} \quad (16)$$

Equation (16) shows that the greater the back tension, the smaller the value of  $P_0$ . As a result,  $\sin \gamma / \sin \alpha$  decreases and the neutral plane moves forward. Similarly, the front tension causes the neutral plane to move backward. For rolling under zero tension,<sup>4</sup> we have  $P_0 = P_1 = \beta \sigma_s$ , and

$$\frac{\sin \gamma}{\sin \alpha} = \frac{2R}{H} - \sqrt{\left(\frac{2R}{H}\right)^2 - \frac{2R}{H} + \frac{1}{2}} \quad (17)$$

The values of  $P_1$  and  $P_0$  can be found from the equilibrium condition of the input and output forces and the plasticity equation. Substituting into (15), we have

$$n_o = C_m + \frac{mL}{4h} - \frac{mL}{24\lambda R} \left(2 - \frac{\sin \gamma}{\sin \alpha}\right) - \frac{\sigma_0 + \sigma_1}{2K} \quad (18)$$

where

$$C_m = \frac{1}{2} \left( \sqrt{1 - m^2} + \frac{1}{m} \arcsin m \right)$$

and  $\sigma_0$  and  $\sigma_1$  are the average tension per unit area on the back and front cross-sections, respectively.

## 2. Plastic deformation friction factor $m$

The coefficient  $m$ , having a value from 0 to 1, is related to the contact friction coefficient  $\mu$  and the form parameter  $L/h$  of the deformation zone. To determine the value of  $m$ , we follow the plasticity theory<sup>4,5</sup> to solve the differential equation (8) ( $t_x = \mu P_x$  in the gliding zone), find its integral average and plot  $m$  as a function of  $L/h$  with  $\mu$  as a parameter,<sup>3</sup> as shown in Figure 2.

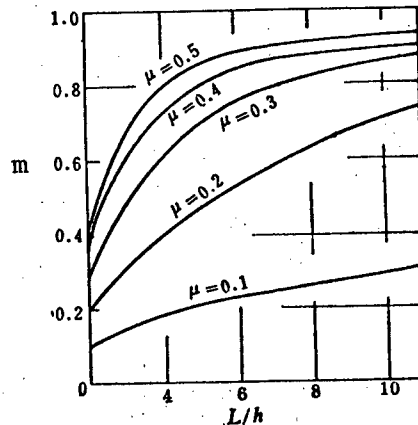


Figure 2. Relationship Between  $m$ ,  $\mu$ , and  $L/h$

### 1.3 Theoretical calculation of the uranium rod rolling force

The rolling of uranium rod is done under zero tension. We proceed to calculate the rolling force assuming known part dimensions  $H$  and  $h$  (converted from the aperture chart) and fixed rolling temperature and contact friction coefficient  $\mu$ , see Table 1.

1.  $n_{\sigma}$

For rolling under no tension, (18) simplifies to

$$n_{\sigma} = C_m + \frac{mL}{4h} - \frac{mL}{24\lambda R} \left( 2 - \frac{\sin \gamma}{\sin \alpha} \right) \quad (19)$$

$n_{\sigma}$  is found from Equation (19) and Figure 2.

2.  $n_v$

$n_v$  is a function of the deformation velocity  $U$  and

$$U = \frac{2v}{H+h} \sqrt{\frac{H-h}{R}}$$

$n_v$  can be found from the value of  $U$  and the curves in Reference 6.

3.  $\sigma_s$

$\sigma_s$  is found from Figure 3 once the rolling temperature is known.

4.  $\beta$

$\beta$  depends on the ratio of the second principal strain  $\varepsilon_2$  and the third principal strain  $\varepsilon_3$ .  $\beta$  can be found from Reference 1.

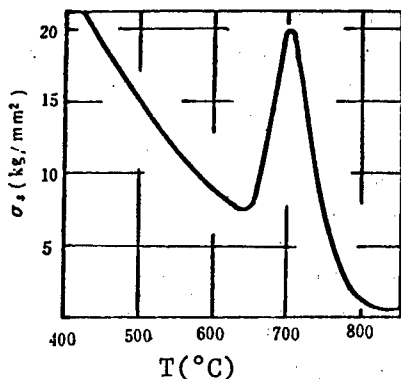


Figure 3. Temperature Dependence of the Plastic Deformation Resistance of Uranium

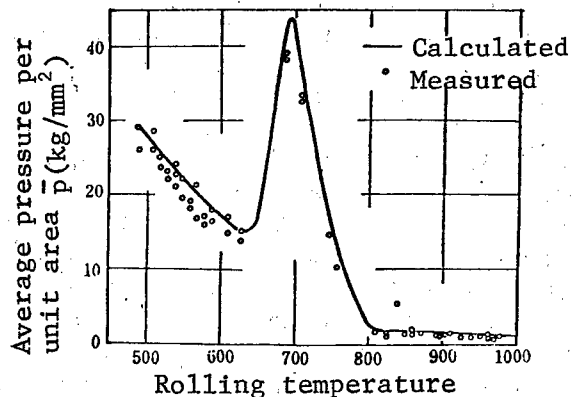


Figure 4.  $\bar{p}$ -T Relationship

Table 1. Dimension Data and Major Parameters

Machine Channel Parameter	φ 450				φ 220			
	1	2	3	4	1	2	3	4
Working radius of roll $R$ (mm)	200.23	201.6	203.15	215.32	97.42	98.34	99.4	100.4
Height before rolling $H$ (mm)	66.72	59.98	56.67	52.76	29.00	28.00	24.83	23.97
Height after rolling $h$ (mm)	49.54	46.8	43.97	39.37	25.17	23.32	21.21	19.2017
$\lambda = h/H$	0.7425	0.7803	0.7760	0.7462	0.8679	0.8329	0.8542	0.8010
$\epsilon_s = \frac{H-h}{H}$ (%)	25.75	22.00	22.4	25.37	13.21	16.71	14.58	19.90
Contact arc length $L$ (mm)	58.02	51.12	50.40	53.28	19.22	21.33	18.88	21.75
$L/h$	1.1712	1.0923	1.1462	1.3533	0.7636	0.9147	0.89	1.133
Cross-sectional area $F_1$ (mm <sup>2</sup> )	4558	3794	3166	2638	980	807	700	557
Projected area of contact $F$ (mm <sup>2</sup> )	4240	3990	3124	2722	830	985	855	821
Width $\Delta b$ (mm)	6.00	4.18	4.96	5.01	0.70	1.05	0.72	1.20
Linear velocity roll surface $V$ (mm/sec)	724.8	724.8	724.1	732.1	354.2	357.6	351.4	365.1
Deformation velocity $U$ (1/sec)		3.47	3.60	3.96	2.59	3.04	2.91	3.68
$\sin \gamma / \sin \alpha$	0.477	0.480	0.488	0.484	0.480	0.481	0.483	0.484

From (1) and (2), the rolling pressure is computed. Figure 4 shows a comparison of the theoretical and experimental values of  $\bar{p}$ .

## II. Measurement of the Rolling Pressure of Uranium Rods

Using an electrical method we measured the rolling pressure, the contact friction coefficient  $\mu$  and the part dimensions before and after rolling. The apparatus used are a model 63-2 dynamic strain gauge, a model Scl eight trace oscilloscope and a timer. The transducer is homemade, the resistance strain element is a  $120\Omega \pm 0.4$  percent model 3x13 unit with a sensitivity coefficient of  $2.126 \pm 0.67$  percent and calibrated on a 60t hydraulic machine. In the high temperature ( $\gamma$  phase) rolling, the temperature is measured simultaneously by a contact pyrometer and an optical pyrometer. In the  $\alpha$  and  $\beta$  phase rolling, the heating is provided by a salt bath and the temperature is measured with a platinum-rhodium thermocouple and an optical pyrometer. The measurement errors attributable to the instrument are less than 5 percent. The  $\gamma$  phase rolling facility is a  $\phi 450$  twin roll reversible mill, the heating is done with an intermediate frequency induction furnace and the ingots are  $\phi 850 \times 680$  in size. The  $\alpha$  and  $\beta$  phase rolling facility is a  $\phi 220$  twin roll mill with a salt bath and the blanks are  $\phi 37 \times 200$  rods with  $\gamma$  phase quench. Both systems are of the elliptical-circular type and only the parameters of the first four channels are measured. Table 1 shows the dimension data.

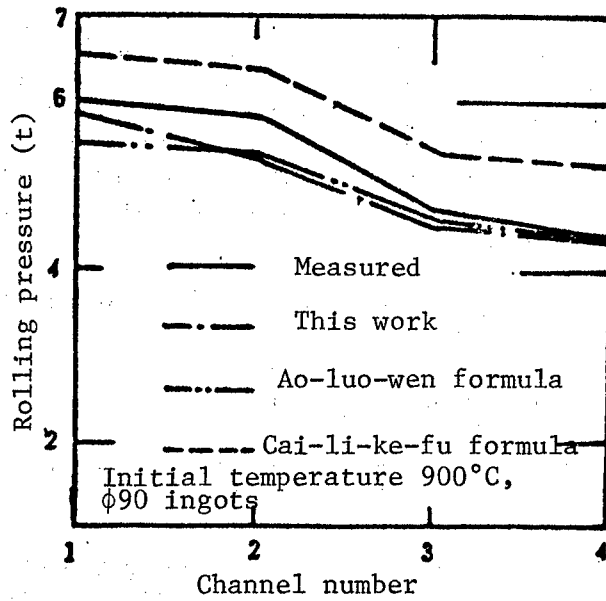


Figure 5. Comparison of the Measured and Theoretical Rolling Pressures for the  $\gamma$  Phase Rolling

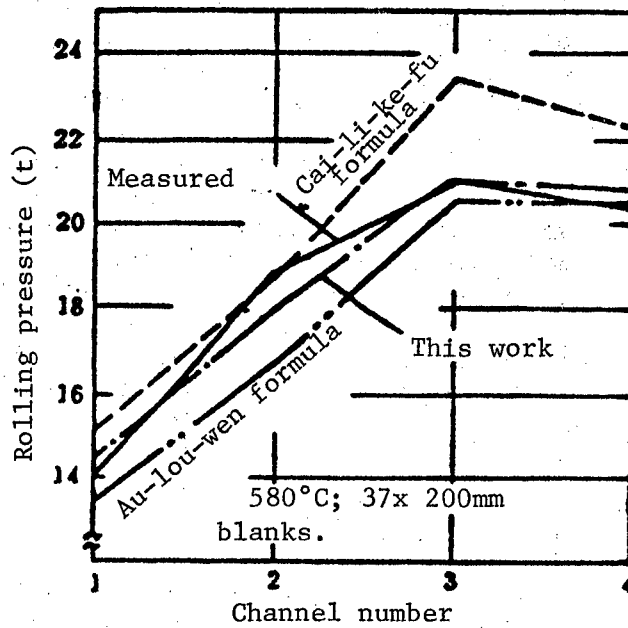


Figure 6. Comparison of the Measured and Theoretical Rolling Pressure for the  $\alpha$  Phase (Channels 1-4 in the  $\phi 450$  Rolling Mill)

The cross-sectional area of the part is measured as follows: The sample part is first cooled to room temperature and a cross-section is machined, an imprint is then made on a graph paper and the number of squares counted, the cross-sectional area is then computed by multiplying by the coefficient of thermal expansion. The height of the part is computed using the method of Reference 2. The projection area of the contact surface is obtained by an enlargement graphical method.

The rolling pressure is computed from the peak value of the experimentally obtained oscilloscope curve:

$$P_{\text{total}} = P_1 + P_2$$

where  $P_1$  and  $P_2$  are respectively the pressures measured by the left and right pressure sensors.

The contact friction coefficient  $\mu$  is measured using two methods: (1) The forward gliding coefficient is first measured, the neutral angle is computed using the (Ba-fu-luo-fu) formula, the contact friction coefficient is then computed using the relationship between the neutral angle and the contact friction coefficient.<sup>2</sup> (2) The contact friction coefficient is computed from the measured limiting friction angle. For  $\gamma$  phase rolling,  $\mu = 0.42-0.48$ ; and for  $\alpha$  and  $\beta$  phase rolling,  $\mu = 0.28-0.33$ .

The measured rolling pressure and the theoretically calculated rolling pressure are compared in Figures 5 and 6. The figures indicate that, using the formula in this paper, the agreement is good for both high temperature rolling and low temperature rolling. Values computed from the Cai-li-ke-fu formula are higher than the measured results because the formula is only valid for the rolling of thin plates with a small coefficient of friction. Values computed from the (Au-lou-wen-ba-si-ke) formula are quite close to the experimental results for high temperature rolling but too low for low temperature rolling. This is because that in low temperature rolling  $\mu$  is about 0.3 and the formula is only accurate when  $\mu$  is greater than 0.4 and has large error<sup>1</sup> for  $\mu = 0.2-0.3$ . The formula presented here has therefore a wider range of applicability.

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APPLIED SCIENCES

PULSED NEUTRON TECHNIQUE, ITS APPLICATIONS IN HEAVY-WATER ZERO POWER REACTOR WITH LOW ENRICHED URANIUM FUEL

Beijing HE KEXUE YU GONGCHENG [CHINESE JOURNAL OF NUCLEAR SCIENCE AND ENGINEERING] in Chinese Vol 4 No 2, Jun 84 pp 175-177

[Article by Wang Meijun [3769 3270 0689], Luo Zhanglin [5012 3864 3829], Wang Zhengbang [3769 2182 6712], Zhao Pintai [6392 0756 0669], Cheng Wenhua [2052 2429 5478], Xia Yi [1115 5042], and Li Wenhui [2621 2492 5706] of the Institute of Atomic Energy, Chinese Academy of Sciences; Manuscript received 3 December 1981]

[Text] I. Brief Description of the Principles

The experimental principles of the pulsed neutron source have been reported in the open literature. Due to the existence of photoneutron effect in heavy-water reactors, the life of undelayed neutrons is long and the time constant  $\alpha_0$  characteristic of the decay is small. There are consequently special problems in the experimental procedure and in the data processing when a pulsed neutron source is used in a heavy-water reactor. To solve these problems, we made the study reported here.

1.1 The  $\alpha_0$  method

The reactivity, in terms of the characteristic time constant  $\alpha_0$  of the reactor and the undelayed neutron decay constant  $\alpha$ , may be expressed as follows:

$$-\frac{\rho}{\gamma\beta} = \frac{\alpha - \alpha_0}{\alpha_0} \quad (1)$$

where  $\rho$  is the reactivity and  $\gamma\beta$  is the effective number of the delayed neutrons.

The undelayed neutron decay constant  $\alpha_c$  in the critical state is often found using a subcritical extrapolation method and it is used in place of the characteristic time constant  $\alpha_0$ . It must be pointed out, however, that undelayed neutrons in a heavy-water reactor have a long life and  $\alpha_c$  is small. It is therefore very difficult to separate the undelayed neutron decay from the delayed neutron decay when the state is close to critical. We used an iterative approach method in fitting  $\alpha_c$  and obtained good results.

## 1.2 The area method

Let us divide the neutrons in the reactor into undelayed neutrons  $N_p(t)$  and delayed neutrons  $N_d(t)$ . At  $t = 0$  and within  $t = 1/R$  at the end of one cycle, there are no undelayed neutrons in the reactor. The experiments were done under the condition  $\alpha \gg R \gg \lambda_i$ . The formula of the area method is therefore given by:

$$-\frac{\rho}{\beta} = \frac{\langle A_p \rangle}{\langle A_d \rangle} = \int_0^{1/R} N_p(t) dt / \left( \frac{1}{R} \bar{N}_d \right) \quad (2)$$

Here  $R$  is the frequency of the pulsed neutron source,  $\lambda_i$  is the decay constant of the parent nuclei of the  $i$ th group of delayed neutrons,  $\bar{N}_d$  is the average background of the delayed neutron,  $\langle A_p \rangle$  and  $\langle A_d \rangle$  are respectively the undelayed neutron area and the delayed neutron area. In a heavy-water reactor  $\alpha \gg R$  is often satisfied but not  $\alpha \gg \lambda_i$ . This implies that there would be decay of the delayed neutron within one cycle and the delayed neutron background is no longer constant. The variation of the delayed neutron must be considered in seeking the solution of the delayed neutron area. To this end we used a five parameter fitting method in finding  $N_d(t)$  and then computed the integral average  $\bar{N}_d = R \int_0^{1/R} N_d(t) dt$ .

In addition, we also used the improved area method and the  $\frac{K\bar{\gamma}\beta}{\ell}$  method.

## II. Experimental Setup and Data Processing

Our experiments are conducted in a heavy-water zero-power reactor with low enriched uranium fuel.<sup>2</sup> We measured the efficiency of the control rods and the targets for two fuel concentrations (2 percent and 3 percent) and for two lattice spacings (9.2 cm and 13 cm). The control rods are 30 mm diameter cadmium rods and boron carbide rods. Iron rods 30 mm and 40 mm diameter are used to simulate the strong absorption targets. All the rods have the same height as that of the active volume.

The experiments make use of the Chinese-made neutron source,<sup>3</sup> a model KY-540G neutron counter connected to a multichannel analyzer, and a BF<sub>3</sub> neutron counter tube. The counter output pulses are reshaped with a model 5JZ-21 NAND gate circuit. The risetime of the leading edge of the pulse is reduced to 30ns for better resolution. The system resolution time is determined to be 1.8  $\mu$ s using the direct solution method and the power comparison method.

The interference of higher harmonics is effectively eliminated using a sliding procedure. Numerical comparisons are made using four different methods: the backfitting method,<sup>4</sup> the four parameter direct fit method, the parameter reduction method, and the five parameter fit method. The results show that the different methods all agree to within 5 percent as long as the time window of the data satisfies the particular method used.

### III. Results and Discussion

We measured the efficiency of the targets at different locations for the 3 percent 9.2x56x7 configuration. Table 1 shows some of the results obtained from different data processing methods, including the water level period method.

Table 1. Measurement Results

Reactivity $\rho$ (- $\beta$ ) Scheme	Method $\alpha$ method	area method	Improved area method	$\frac{K\bar{\gamma}\beta}{l}$ method	Water-level period method
(7-7) $\phi$ 42 Fe	3.40	3.24	3.18	3.07	2.63
(7-7) $\phi$ 30 Cd	4.89	4.67	4.47	4.44	3.69
(7-7) $\phi$ 30 B <sub>4</sub> C	6.00	5.38	5.65	5.47	4.69
(10-4) $\phi$ 30 Fe	1.38	1.17	1.14	1.10	1.05

As can be seen from Table 1, (1) the result of the  $\alpha$  method tends to be too high, mainly because  $\alpha_0$  of the net reactor is used. This is consistent with the conclusion for the light-water reactor except that, in a heavy-water reactor, the effective radius of the control rod is large and the lattice characteristic parameter  $\alpha$  changes more after the insertion of the control rod. We have shown experimental that, for the specific configuration discussed here, the  $\alpha_0$  value based on the net reactor is 20-30 percent higher than that of other methods even if the control rod efficiency is -7%. Table 2 shows the subcriticality for the 3 percent 9.2x56x7 configuration at different water levels using the water level period method and the pulse method.

Table 2. Results Obtained Using the Pulse Method and the Water Level Period Method

Water level	$H_{eff}$ (cm)	86.84	87.39	87.76	88.22	88.62
$\alpha$	(S <sup>-1</sup> )	25.03	21.41	17.92	15.91	11.66
$\rho$ (- $\beta$ )	$\alpha$ method	2.22	1.76	1.31	1.05	0.50
	period method	2.16	1.65	1.30	0.86	0.49

Table 2 shows that the two methods agree very well. It means that changes in subcriticality caused by the water level variation do not affect the lattice characteristics and that good results can be obtained using the  $\alpha$  method as long as the correct  $\alpha_0$  is used. (2) For the configuration considered here, the other three methods beside the  $\alpha$  method produced results consistent with each other within 5 percent. All these results are greater than that using the water level period method due to a spatial effect.

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CSO: 4008/375

APPLIED SCIENCES

COMPUTER-AIDED ANALYSIS OF ARBITRARY-SHAPED THIN-WIRE ANTENNAS

Nanjing NANJING GONGXUEYUAN XUEBAO [JOURNAL OF NANJING INSTITUTE OF TECHNOLOGY] in Chinese No 4, 20 Dec 84 pp 61-67

[Article by Hong Wei [3163 0251] and Zhang Wenxun [1728 2429 8113], Department of Radio Engineering: "Computer-Aided Analysis of Arbitrary-Shaped Thin-Wire Antennas"\*]

[Text] Text of English Abstract: The analysis of excited and loaded arbitrary-shaped thin-wire antennas has been carried out in this paper. The numerical results for a GAUSS-type antenna agree with the experimental results.

I. Introduction

Theoretical research on arbitrary-shaped thin-wire antennas has significance in two respects, first, for carrying out theoretical computations on thin-wire antennas of various shapes actually being used, and second, from the theoretical standpoint to find for an antenna shape which is optimal for a certain norm. K.K. Mei (1965), Hu. H. Chao, et al. (1970), D.C. Kuo (1972), M. Kominami (1981), and Zhang Wenxun [1728 2429 8113]<sup>[2]</sup> have put out articles on arbitrary-shaped thin-wire antennas, among which Hu. H. Chao and B.J. Strait have provided computer programs using juliang [4251 6852] method analysis<sup>[3]</sup>, but this program is not convenient for doing optimization processing and because it has adopted the rectangular pulse base function and improved point matching method, and carries out mujishujiexiang [1612 4787 2422 2066 7309] processing on the Green function, it limits its accuracy. This article uses instead a triangular pulse base function and Galerkin method, the computational formulas obtained are simple and accurate, the computer program is easy to use as a subprogram call in an optimization program.

In 1976 Landstorfer<sup>[4]</sup> proposed the control curved vibrator shape for realizing the concept of gain optimization, and he has also published many articles presenting the experiments and computation results of optimum shaped vibrators, however, all have proceeded from the assumption of sinusoidal distribution of the current on the vibrator which does not conform to actual circumstances.

\* This paper was received 30 March 1984.

This paper uses the juliang method to find the actual current distribution on a curved vibrator, and uses it as a basis for computing the directional map, gain, and input admittance, and on the basis of these analytical computations, carries out optimal design of the curved vibrator. The analytical computations in this paper have already been completed, but the optimal design is still going on. The optimal results achieved by Liang Changhong [4731 2490 3163] have been published abroad,[5] thus, this writer is taking another quasi-optimal target and making an independent report on the results of early stage research.

## II. General Formula Deduction

### 1. Current Distribution

Formulas for vector position and scalar position

$$A(\mathbf{r}) = \mu \int_1 s' I(s') G(\mathbf{r}/\mathbf{r}_{s'}) ds'; \quad (1)$$

$$\Phi(\mathbf{r}) = \frac{j\eta}{K} \int_1 \left[ \frac{d}{ds'} I(s') \right] G(\mathbf{r}/\mathbf{r}_{s'}) ds', \quad (2)$$

see Figure 1 for the meaning of the geometric quantities in the formula. The electrical field is represented by the vector position and scalar position.

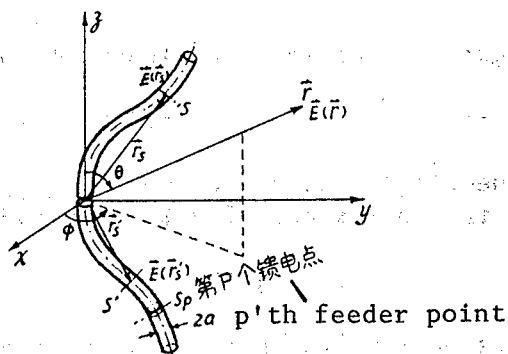


Figure 1. Arbitrary-Shaped Thin-Wire Antenna

$$\begin{aligned} E^s(\mathbf{r}) &= -j\omega A(\mathbf{r}) - \nabla \Phi(\mathbf{r}) \\ &= -\frac{j\eta}{K} \int_1 \left[ s' K^2 G(\mathbf{r}_s/\mathbf{r}_{s'}) \right. \\ &\quad \left. + \nabla G(\mathbf{r}_s/\mathbf{r}_{s'}) \frac{d}{ds'} \right] I(s') ds' \end{aligned} \quad (3)$$

The tangential electrical field of the antenna surface

$$\begin{aligned} E_t^s(\mathbf{r}_s) &= -\frac{j\eta}{K} \int_1 \left[ s \cdot s' K^2 G(\mathbf{r}_s/\mathbf{r}_{s'}) \right. \\ &\quad \left. + \frac{\partial}{\partial s} G(\mathbf{r}_s/\mathbf{r}_{s'}) \frac{d}{ds'} \right] I(s') ds' \end{aligned} \quad (4)$$

Boundary condition of the antenna surface

$$E_t^i(\mathbf{r}_s) + E_t^r(\mathbf{r}_s) = 0. \quad (5)$$

Excitation field  $E_t^i$  made up of the  $\delta$ -source of a point on the antenna

$$E_t^i = \sum_{p=1}^N V_p \delta(s - s_p).$$

Substituting this in the boundary condition (5) we get the operator equation

$$L[I(s')] = \sum_{p=1}^N V_p \delta(s - s_p), \quad (6)$$

in the operator

$$L = -\frac{j\eta}{K} \int_1 ds' \left[ s \cdot s' K^2 G(\mathbf{r}_s / \mathbf{r}_{s'}) + \frac{\partial}{\partial s} G(\mathbf{r}_s / \mathbf{r}_{s'}) \frac{d}{ds'} \right]. \quad (7)$$

We use the linear aggregate of the expanded function to represent the current

distribution function  $I(s') = \sum_{n=1}^N I_n \psi_n(s')$ , substitute it in the operator

function, and use the checking function set  $\{W_m(s) | m=1, 2, \dots, n\}$  to be the inner product to obtain the matrix equation for the two sides

$$[Z][I] = [V]. \quad (8)$$

The generalized impedance matrix  $[X]$  is the  $N \times N$  exponent matrix, its elements

$$Z_{mn} = \langle W_m, L\psi_n(s') \rangle = Z_{mn}^{(1)} + Z_{mn}^{(2)}, \quad (9)$$

in which

$$Z_{mn}^{(1)} = -\frac{j\eta}{K} \int_1 \int_1 s \cdot s' K^2 G(\mathbf{r}_s / \mathbf{r}_{s'}) W_m(s) \psi_n(s') ds' ds; \quad (10)$$

$$Z_{mn}^{(2)} = -\frac{j\eta}{K} \int_1 \int_1 G(\mathbf{r}_s / \mathbf{r}_{s'}) W_m'(s) \psi_n'(s') ds' ds. \quad (11)$$

The transposition of the generalized current matrix

$$[I]^T = [I_1, I_2, \dots, I_N],$$

the elements of the generalized voltage matrix  $[V]$  are

$$u_m = \langle W_m, \sum_{p=1}^N V_p \delta(s - s_p) \rangle = \sum_{p=1}^N V_p W_m(s_p),$$

solving (8) we get

$$[I] = [Z]^{-1}[V] = [Y][V] \quad (12)$$

in which  $[Y]$  is the generalized admittance matrix. Finally, we get the current distribution function

$$I(s') = \sum_{n=1}^N I_n \psi_n(s') = [\Phi]^T [I] = [\Phi]^T [Y][V], \quad (13)$$

in which  $[\Phi]^T = [\psi_1(s'), \psi_2(s'), \dots, \psi_n(s')]$  is the expanded function set matrix.

## 2. Input Admittance

The current at the  $k$ 'th excitation point  $s_k$

$$I(s_k) = [\Phi(s_k)]^T [Y][V] = \sum_{p=1}^N Y_{i_n}^{(k,p)} V_p, \quad (14)$$

in which

$$Y_{i_n}^{(k,p)} = \sum_{i=1}^N \sum_{j=1}^N \psi_j(s_k) Y_{ji} V_i(s_p)$$

Written in matrix form

$$[I(s_k)] = [Y_{i_n}^{(k,p)}][V_p], \quad (15)$$

or abbreviated

$$[I_{i_n}] = [Y_{i_n}][V_{i_n}], \quad (16)$$

in which  $I(s_p)$ ,  $V_p$  and  $Y_{i_n}^{(p)}$  are the current, voltage, and input admittance respectively of the  $p$ 'th feeder point;  $Y_{i_n}^{(k,p)}$  is the mutual admittance between the  $k$ 'th and the  $p$ 'th feeder point;  $[Y_{i_n}]$  is called the input admittance matrix.

## 3. Loading

Viewing the voltage of the distribution or lumped loading  $Z_1(s)$  as back electromotive force, we have

$$[Z^W][I] = [V] \quad (17)$$

in which  $[Z^W] = [Z^L] + [Z^0]$ ,  $[Z^0]$  defines the  $[Z]$  above when there is no loading,  $[Z^L]$  is the element

$$Z_{n,n}^L = \langle W_n, Z_1(s) \psi_n \rangle$$

Thus (12) can be changed to

$$[I] = [Z^W]^{-1}[V] = [Y^W][V] \quad (12')$$

#### 4. Directionality and Gain

On the basis of the formula derived in [6] using the reciprocity theorem (see Figure 2) we compute the directionality and gain

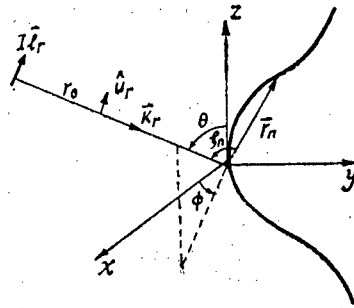


Figure 2. Wire Antenna and Remote Dipole

$$E_r = \frac{\omega \mu \epsilon^{-jkr_0}}{j4\pi r_0} [V^r]^T [I]; \quad (18)$$

$$g(\theta, \phi) = \frac{\eta k^2}{4\pi} \cdot \frac{|[V^r]^T [I]|^2}{R_c \{ [V_{i_n}]^T [I_{i_n}] \}} \quad (19)$$

in which

$$[V^r]^T = [E^r(1) \cdot \Delta l_1, E^r(2) \cdot \Delta l_2, \dots, E^r(N) \cdot \Delta l_N];$$

$$E^r = u_r e^{-jkr_n \cos \theta_n};$$

$\bar{I}_n$  is the average current at the n'th section.

### III. Computation Formulas Under Triangular Pulse Base Function and Galerkin Method

If we normalize the triangular pulse base function (see Figure 3).

$$T_n = \begin{cases} t & 0 \leq t \leq 1 \quad (s_{n-1} \leq s \leq s_n); \\ 1-t & 0 \leq t \leq 1 \quad (s_n \leq s \leq s_{n+1}); \\ 0 & \text{other sections.} \end{cases} \quad (20)$$

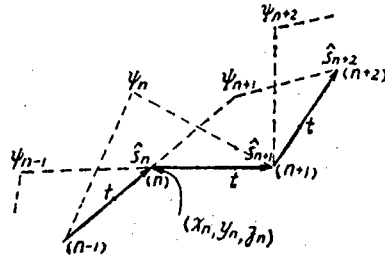


Figure 3. Sectional Base Function and the Local Coordinates

The geometrical relationships

$$\cos \alpha_i = N(\bar{X}_i - \bar{X}_{i-1});$$

$$\cos \beta_i = N(\bar{Y}_i - \bar{Y}_{i-1});$$

$$\cos \gamma_i = N(\bar{Z}_i - \bar{Z}_{i-1});$$

$$\cos^2 \alpha_i + \cos^2 \beta_i + \cos^2 \gamma_i = 1;$$

$$s_m \cdot s_n = \cos \alpha_m \cos \alpha_n + \cos \beta_m \cos \beta_n + \cos \gamma_m \cos \gamma_n;$$

$$|\mathbf{r}_m(t)|^2 = \left( \bar{X}_{m-1} + \frac{t}{N} \cos \alpha_m \right)^2 + \left( \bar{Y}_{m-1} + \frac{t}{N} \cos \beta_m \right)^2 + \left( \bar{Z}_{m-1} + \frac{t}{N} \cos \gamma_m \right)^2,$$

in which  $\bar{X}_i = X_i/N$ ;  $\bar{Y}_i = Y_i/N$ ;  $(\cos \alpha_i, \cos \beta_i, \cos \gamma_i)$  is the directional cosine of the  $i$ 'th section;  $t$  is the local coordinate, and  $ds = \Delta l dt$ .

The average voltage on each section can be found from the relational

$$\text{expressions } \bar{I}_0 = \frac{I_1}{2}, \quad \bar{I}_n = \frac{1}{2}(I_{n-1} + I_n), \quad \bar{I}_{N+1} = \frac{1}{2} I_N$$

and now

$$u_m = \langle W_m, \sum_{p=1}^N V_p \delta(s - s_p) \rangle = \begin{cases} V_m, & m=p; \\ 0, & m \neq p. \end{cases} \quad (21)$$

$$[Y_{i,n}] = [Y] \quad (Y_{i,n}^{(k,p)} = Y_{k,p}) \quad (22)$$

Only when there is an excitation source

$$u_m = \begin{cases} V_k, & m=k; \\ 0, & m \neq k. \end{cases} \quad (23)$$

the input admittance

$$Y_{i,n}^{(k,k)} = Y_{k,k} \quad (24)$$

#### IV. Numerical Results

For the Gauss-type vibrator ( $Y=A[1-\exp(-Bx^2)]$ ) researched in [1] in this paper, see Figure 4, the computations were carried out under unloaded conditions of  $A=0.4\lambda$ ,  $B=3.75/\lambda$ ,  $N=24$ , the results are presented in Figures 5-9. Comparison with the experimental curves and theoretical curves given in [1], Figure 6 shows that the results of this paper have a good fit with the experimental curve.

[Figures 4 and 5 below; Figures 6-9 on following page]

This paper was completed with the support of our Institute's Electromagnetic Field and Microwave Technology Laboratory, and the computer program herein had the enthusiastic help of teacher Yuan Jinyun [5913 6930 0061] here we express our thanks.

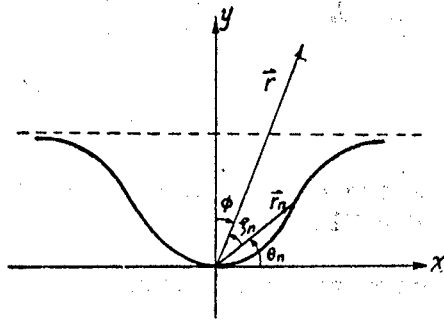


Figure 4. Gauss-Type Thin-Wire Vibrating Antenna

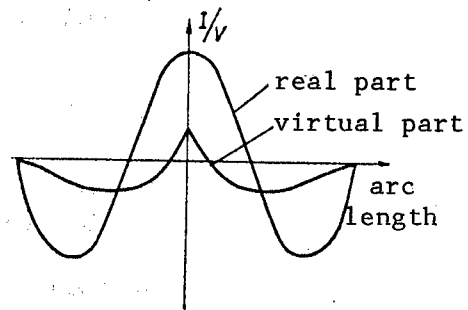


Figure 5. Current Distribution of a Gauss-Type Thin-Wire Antenna

——— Theoretical value in this paper  
 ——— [4] theoretical value  
 - - - - [4] experimental value

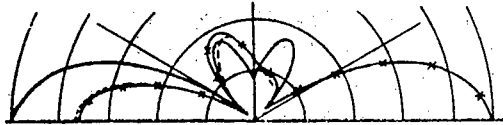


Figure 6. E-Plane Directional Map

——— Theoretical value in this paper  
 - - - - [4] experimental value

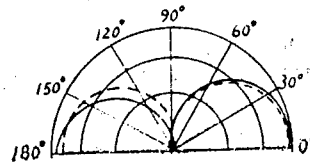


Figure 7. H-Plane Directional Map

——— [4] results  
 ——— results in this paper

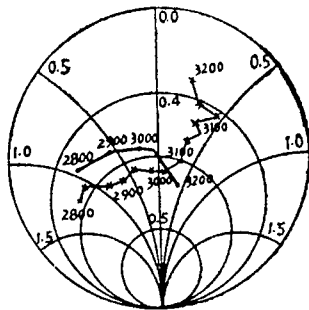


Figure 8. Impedance Characteristics

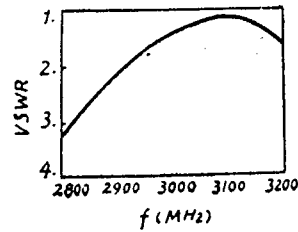


Figure 9. Standing-Wave Characteristic Curve

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CSO: 1008/1043

4 September 85

## APPLIED SCIENCES

## ARTICLE TRACES CHINA'S EFFORTS TO DEVELOP ECM AIRCRAFT

Beijing RENMIN RIBAO in Chinese 6 Feb 85 p 4

[Text] For 10 years Ma Yuqin [7456 3768 2953], an engineer with the maintenance office of a certain Air Force unit in the Nanjing Military Region and head of the electronic countermeasures laboratories, with the help of related research personnel has worked to design and refit a number of ECM aircraft, greatly enhancing the war-fighting capabilities of our military under modern electronic [warfare] conditions. Early last year, he received the Air Force Award for Major Scientific Achievement, Second Class.

People learned from the world-shattering events in the sea war of the Maldives and the air war over the Bekaa Valley that electronics would play a major role in future wars. ECM aircraft are important weapons that will ensure victory over an enemy and constitute a deciding factor in the course and outcome of modern warfare. They can observe the deployment of enemy radar facilities and destroy these systems, disrupt control of weapons, and paralyze command and control systems, thereby providing cover for successful military operations.

In the early 1950's, Ma Yuqin, after graduating from "hangxiao" [probably an abbreviation of "hangkong xuexiao"--flight school], was determined to make a contribution to China's electronics undertaking. Backed by his own expertise in radar, he systematically poured through some 300 publications, including "Basic Electronics," "Applied Electronics," and "Electronic Countermeasures" and took some 200,000 words in notes. He improved some 10 items of science and technology. He published 6 technical articles in both military and non-military magazines and was engaged as a consultant by a certain research institute under the Ministry of Electronics Industry.

In 1974, after Ma Yuqin was given the task of beginning [a project on] ECM aircraft, he at once plunged into intense research work. After 2 years, he produced the first batch of Chinese-designed and equipped EMC self-defense aircraft. Following this, along with research personnel from involved research units, he received the mission of researching special--use ECM aircraft. In order to determine the capabilities and parameters of refitted aircraft, he actually went up with the aircrews--at considerable risk. On the basis of materials gathered first-hand, he wrote and published a lengthy scientific article in "Passive Interference and Photoelectric Countermeasures" magazine.

CSO: 4008/400

APPLIED SCIENCES

USAGES OF ORGANIC MEMBRANES IN ELECTROLYTIC INDUSTRY DESCRIBED

Beijing HUAXUE TONGBAO [CHEMISTRY] in Chinese No 5, 18 May 85 pp 37-42

[Article by Li Jisen [2621 1015 2773], Shanghai Organic Chemistry Institute, Chinese Academy of Sciences]

[Text] Electrosynthesis is a method of preparing chemical products through electrode reactions. It has been, for many years, applied mainly to produce inorganic products. Examples include the electrolysis of water to produce hydrogen and oxygen, the electrolysis of saline solution to produce chlorine and caustic soda and the electrolysis of ammonium sulfate solution to produce hydrogen peroxide. But in recent years rapid advances have been made in the area of organic compound preparation. For example, industrial-scale productions have been achieved on the preparation of adiponitrile by dimerization of acrylonitrile through electro-reduction, the preparation of tetraethyllead and the preparation of propylene oxide from propylene. In the above-mentioned electrosyntheses, the applications of organic membranes have significant impacts. Due to these applications, the variety of membranes have been greatly enriched, their properties improved and many chemical reactions have been realized that are impossible under ordinary conditions. Therefore, the applications of organic membrane in electrolytic industry have drawn increasing attention.

I. Functions of Membrane in Electrolytic Reactions

When carrying out chemical reactions in electrolytic cell, oxidation reaction occurs at anode while reduction at cathode. Because products formed by one electrode can easily be destroyed by another, it is necessary to separate anode chamber from cathode chamber in order to assure the smooth progress of electrolytic reaction. Membranes must be used in the following situations:

1. To avoid the mixing of gases produced at both electrodes.
2. To avoid the mixing of materials from both chambers through diffusion or convective flow.
3. To avoid the solid material formed on one electrode comes in contact with another.

The requirements of membrane are as follows:

1. Small resistance.
2. Good chemical stability. Many electrolytic reactions are done in stronger acid or base media and produce strong oxidants so the membrane materials are required to be able to resist chemical corrosion.
3. Permselectivity against ions in electrolyte solution.
4. Certain mechanical strength so that it won't tear in the cell assembly or during use.
5. Low cost.

## II. Classifications and Characteristics of Membrane

Membranes can be divided into two major categories of organic membrane and inorganic membrane according to the materials used.

In general, inorganic membranes are passive membranes. They depend on electrolyte solution that filled the numerous pores in the membrane to gain conductivity. Their permselectivity against ions in electrolyte solution is totally dependent on pore size and membrane thickness. Therefore, inorganic membranes generally have larger resistance, poorer permselectivity and lower current efficiency. Commonly used inorganic membranes include asbestos membranes, porcelain membranes, porous glass membranes and metallic membranes.

Organic membranes include ion exchange membranes and organic porous membranes. Ion exchange membranes are currently widely used and being developed at fast pace. They are organic polymer membranes, in which ion exchange groups are attached to the backbone of polymer during manufacturing processes. For example, those with sulfonate groups are called cation exchange membranes (or simply cationic membranes), which have the ability to block the passage of cations while allowing anions to go through in electrolyte solution. Those with quaternary ammonium groups are called anion exchange membranes (or simply anionic membranes), which block the passage of cations and allow anions to go through. Ion exchange membranes have wide applications<sup>1</sup> and show great vitality in their applications as electrolytic membranes.<sup>2,4</sup> Compared with inorganic membranes, they have the advantages of low resistance, good permselectivity and high current efficiency. Furthermore, organic membranes are synthetic polymer membranes which enjoy the advantages of ample supply of raw materials and large selections.

According to their operating conditions, membranes can be divided into dense membranes and loose membranes. The function of dense membranes is to separate anode chamber from cathode chamber in electrolytic cell so that there is no mixing of the electrolyte solutions in both chambers, which in general have different compositions. There are higher requirements

for this kind of membranes. Besides those generally required for membranes, they should also possess greater counter-diffusion capability, that is exceptionally good permselectivity. In addition, this kind of membranes are generally used in such situation that one side of the membrane is acidic while the other is basic. Therefore, they should also be resistant to acid and base corrosions. Ion exchange membranes belong to this category of membranes.

Loose membranes are different from dense membranes. They allow electrolyte solution to pass through membrane continuously from cathode to anode chamber in order to keep anodic products from cathode chamber. The asbestos membranes used in saline solution electrolysis belong to this category of membranes.

### III. Some Parameters Representing Membrane's Properties

Membranes are generally specified by their porosity. The more pores on the membrane, the larger the pore size and the less the zigzagging, the better the permeation. Porosity is actually measured as volumetric porosity  $\sigma$ ,

$$\sigma = \frac{\text{porosity volume}}{\text{total membrane volume}} \times 100$$

$\sigma$  does not dictate the overall property of membrane, especially for loose membrane. Because even with the same  $\sigma$  value, loose membranes having different pore shapes due to different preparation methods would allow different amount of liquid to pass through. This is expressed as absolute permeation coefficient. Absolute permeation coefficient is related to type of membrane, porosity and degree of zigzagging.

Among the organic membranes, porosity is commonly used to specify highly porous membranes. However, ion exchange membranes are different because in dry and wet states as well as in different media, their pore sizes are different. So their porosities are generally not measured. Rather, their properties are expressed by the following parameters.

1. Conductivity of membrane. Generally speaking, organic polymeric materials are insulators. In order for them to be able to conduct electricity in solution, their properties have to be modified, that is by introducing ion exchange groups, which can function as electrolyte, to the polymer chain. Therefore, the conductivity of organic membranes is related to the type and number (generally expressed as exchange equivalent) of introduced groups. The resistance of membrane is often expressed by the surface resistance ( $\text{Ohm}\cdot\text{cm}^2$ ), specific resistance ( $\text{Ohm}\cdot\text{cm}$ ) or specific conductance ( $\text{Ohm}^{-1}\cdot\text{cm}^{-1}$ .)

2. Permselectivity of ions. The most prominent characteristics of ion exchange membranes is the permselectivity of ions in solution. Its major applications are based on this property, which is dictated by the membrane structure and the concentration of exchange groups. In general, apparent ion transfer number, as determined by measuring membrane's potential difference, can be used to compare membrane's permselectivity of ions.

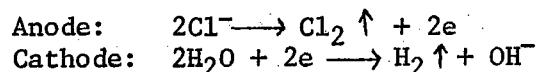
3. Expansion Property. Ion exchange membrane is a kind of polymeric colloid that is strong electrolyte. Therefore, it has different degree of expansion in aqueous electrolyte solution of different concentrations. If this property is ignored when assembling the cell, the concentration change of solution would deform the membrane and affect its useful life. Although the degree of expansion of membranes can be reduced by using reinforced materials or other methods in the process of preparation, even a small degree of expansion would bend and deform or even rupture the membranes when large membrane is used. Therefore, in application, ion exchange membrane is often fully equilibrated in the solution intended to be used before it is installed.

4. Mechanical strength. Membrane's mechanical strength is determined by the chemical structure of membrane material and the strength of reinforce material. In practical applications, the strength requirement is generally not very high and is acceptable as long as it possesses the tensile strength for general applications. However, it has to possess better-than-average anti-bending strength and flexibility. These are generally indicated by blasting strength.

#### IV. Organic Membranes' Applications in Electrolytic Industry

In this article, the following three electrolytic reactions have been chosen as examples to demonstrate the significant impacts and tremendous economic benefits of organic membranes in practical applications.

1. Electrolysis of salt. Electrolysis of salt to produce chlorine gas and caustic soda is one of the basic chemical industries. Its electrode reactions are as follows:



In early days, the electrolysis was done with non-circulating electrolyte solution and porous membrane of cement was used. This kind of membrane allows the passage of ions but keeps cathode and anode solutions from mixing. During electrolysis, both anode and cathode chambers are filled with saturated saline solution. After current is applied, hydrogen gas and caustic soda are produced at the cathode while chlorine gas is produced at the anode. However, despite the use of membrane to separate the two chambers, the cement membrane's poor properties of large resistance and inability to keep  $\text{OH}^-$  from moving toward anode chamber result in the massive diffusion of  $\text{NaOH}$  produced into anode chamber, the amount of which increases with the increase in the concentration of caustic soda. Even at rather low concentration of produced caustic soda, the current efficiency can only be maintained between 70-80 percent and at times reaches as low as 55 percent. This method of electrolysis has now become obsolete.

Electrolysis methods currently being used are mercury process and asbestos membrane reverse-flow electrolysis (or simply membrane method). In the membrane electrolysis method, because the saline solution flows out of the

cell through the membrane, sodium hydroxide formed at the cathode cannot enter the anode chamber, thus greatly raises the current efficiency. But there still exist some drawbacks: (1) High content of sodium chloride in the produced caustic soda fails to meet the requirement of certain industries such as textile. (2) The concentration of caustic solution is low and must be concentrated, hence increases energy consumption. The mercury process employs no membrane but uses the cathode to produce the Na-Hg amalgam, which is then hydrolyzed to produce high concentration, high purity caustic soda. But mercury is a serious public health hazard and people are forced to seek new technology.

The recently developed ion exchange membrane electrolysis retains the advantages of both mercury process and membrane method and overcomes their drawbacks. It is a new electrolysis method that draws wide attention.<sup>4,5</sup> See Figure 1 for its operating principle and Table 1 for comparisons.

There are two types of ion exchange membrane used, the perfluorosulfonate type and the perfluorocarboxylate type<sup>4</sup> (see figures below).

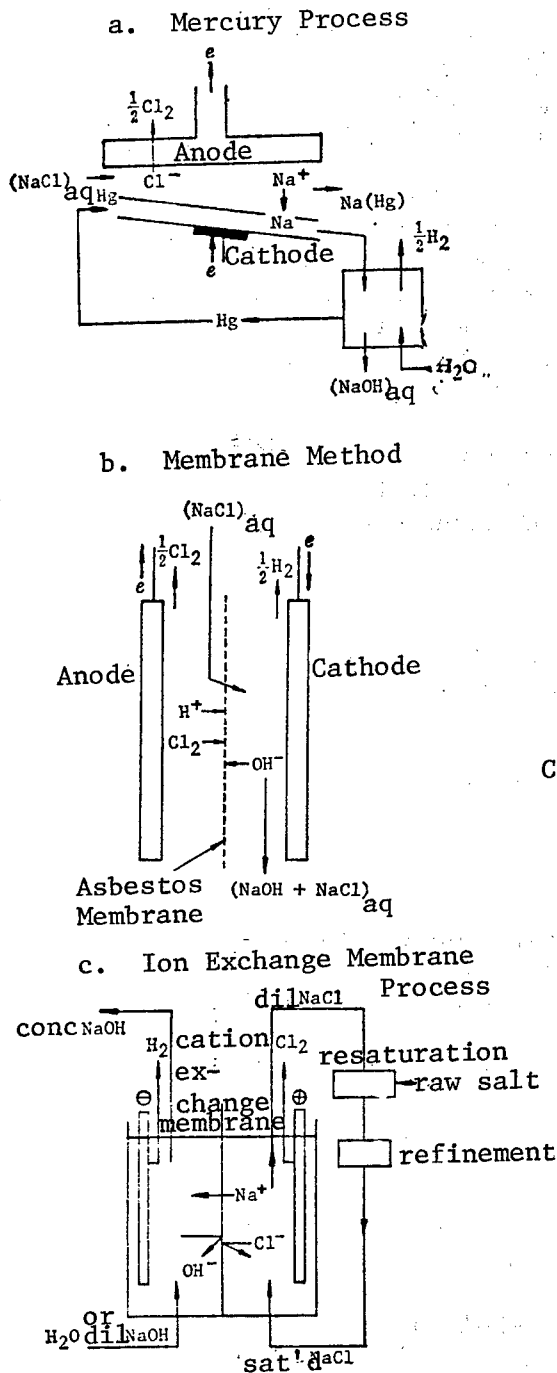


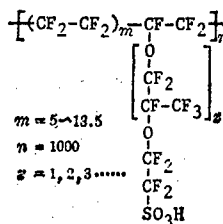
Table 1. Comparisons of Ion Exchange Membrane Method, Mercury Process and Membrane Method.

Item	Technology Composition	Ion Ex-	Mercury	Membrane
		change membrane	Process	Method
NaOH	NaOH%	17~25	49±1	49±1***
	NaCl%	0.01**	0.005	1.0~1.5
	NaClO <sub>2</sub> %	—	—	0.2~0.5
Cl <sub>2</sub>	Cl <sub>2</sub>	99.5	98.8	96.5~98
	H <sub>2</sub>	0.03	0.2~0.5	0.1~0.5
	O <sub>2</sub>	0.2	0.2	1.0~2.5
	CO <sub>2</sub>	0.3	0.4	0.1~0.3
H <sub>2</sub>	H <sub>2</sub>	99.9	99.9	99.9
Cell Voltage		3.8~4.1	4.3~4.4	3.6~3.8
Current Density A/dm <sup>2</sup>		10	60~80	10
Current Efficiency		96	96	96

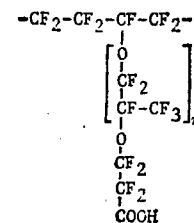
\* Data reported by Asahi Kasei Co. of Japan

\*\* Calculated with 49% NaOH solution

\*\*\* After concentration



Perfluoro-sulfonate Type



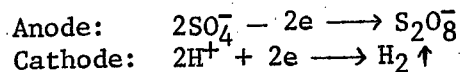
Perfluoro-carboxylate Type

Figure 1. Schematic Diagrams of Ion Exchange Membrane Method, Mercury Process and Membrane Method Cells.

The authors, in collaboration with related factories, have used P-102 and E-105 types of cation exchange membrane as electrolytic membrane to produce reagent grade potassium(sodium) hydroxide from industrial potassium(sodium) hydroxide, which takes the place of mercury process and eliminates mercury pollution.<sup>6</sup> It is still being used by our reagent plants.

2. Hydrogen Peroxide Production by Electrolysis. The production of hydrogen peroxide by electrolysis of ammonium sulfate-sulfuric acid solution gives high purity product with reliable production technology and is suitable for medium and small scale productions. Therefore, large percentage of hydrogen peroxide are produced by electrolysis in our country. However, the electrolysis process has the disadvantages of high electricity consumption and high production cost and faces the challenge of the low-cost anthraquinone oxidation-reduction process. Without such technological transformations as lowering electricity consumption and raising current efficiency, it will lose its competitiveness. In recent years, noticeable results have been achieved in the technological transformation of electrolysis process. Here, the status of organic membrane applications is briefly described.

The key to lowering electricity consumption is the membrane. The currently used cells are rectangular plastic or ceramic ones with four anode frames. Porcelain membranes are used to separate anodes (Pt) from cathodes (Pb) and to keep the ammonium persulfate formed at anodes from being reductively decomposed at cathodes. The electrode reactions are as follows:



The average voltage of the cell is 5.6-6 volts. The reason for high cell voltage is the high resistance of porcelain membrane, which raises the cell voltage by 1-1.2 volts. To reduce the resistance of porcelain membrane, the porosity of membrane must be increased, which in turn would diminish its capability to keep  $\text{S}_2\text{O}_8^{2-}$  from diffusing toward cathodes and results in lower current efficiency. Therefore, the dilemma of lowering resistance and raising ion permselectivity in porcelain membrane cannot be solved.

The authors<sup>7,8</sup> have replaced porcelain membrane with F-101 cationic membrane as cell membrane. Through 8 years of production operation from the pilot-plant scale of 300 ton annual production to the production-scale of 2,000 ton annual production, it becomes clear that F-101 cationic membrane has the following advantages: (1) Small resistance and low cell voltage. It lowers cell voltage by about 1 volt on an average. With the same power supply, cell size can be increased by 20 percent. (2) Good permselectivity against  $\text{S}_2\text{O}_8^{2-}$  ion and its current efficiency is 5-7 percent higher than that of porcelain membrane. Combining these two factors and without altering the original equipment and operating conditions (except the slight modification of anode frame required for the installation of organic membrane), simply replacing the membrane can increase the production by about 25 percent. In other words, for a plant with annual production of

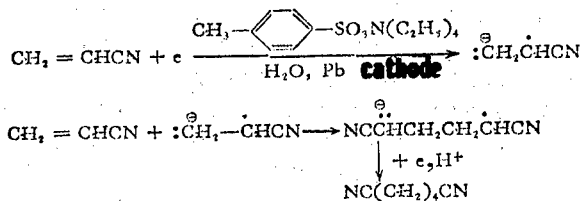
1,000 ton hydrogen peroxide, merely substituting with F-101 cationic membrane can increase the production by about 250 tons. Thus, the electricity consumption to produce 1 ton of hydrogen peroxide is lowered by more than 1,000 kilo-watt-hours. In Table 2, the two membranes are compared.

Table 2. Comparisons of F-101 Cationic and Porcelain Membranes

Name	Item Data	Cell Voltage (V)	Current Efficiency%	Direct Current Consumption Kwh/ton	Useful Life (year)	Quality
F-101 Cationic Membrane		4.5-4.8	85-90	4	2	Pass
Porcelain Membrane		5.5-6.0	80	5	1-2	Pass

F-101 cationic membrane is an ion exchange membrane made of polyvinylidene fluoride so it has better anti-oxidation property. But its production cost is higher. In order to further reduce the cost of hydrogen peroxide, the authors have formulated a new electrolytic membrane made of polyethylene--the 901 membrane.<sup>9</sup> Through pilot-plant test for nearly a year at the related factories, it is shown to have similar properties and effects as F-101 cationic membrane but its cost is only 1/7 that of F-101. Therefore, it can be expected that this will become a popular membrane in the electrolytic technology of hydrogen peroxide production.<sup>10</sup>

3. Preparation of Adiponitrile by Dimerization of Acrylonitrile through Electro-reduction.<sup>4,11</sup> As a starting material for nylon-66, adiponitrile is in short supply. In the past, starting from phenol, adipic acid was prepared through multiple step reactions of hydrogenation, oxidation, etc., which was then converted into adiponitrile by catalysis and ammoniolysis. It is obvious that chemical synthesis involves many steps and the source of phenol is limited. The recently developed electrosynthesis process, in which adiponitrile is made by one step reaction on the electrode using acrylonitrile as starting material, has been operating in the United States and Japan. The reactions proceed according to the following equations:

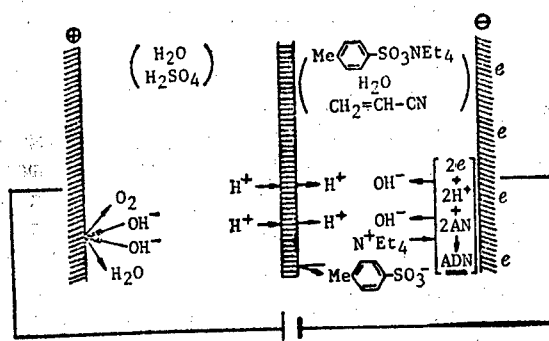


The keys to the success of the reactions are: (1) The use of organic salts like tetraethylammonium p-toluenesulfonate as coelectrolyte to get high concentration of acrylonitrile (10-15 percent) in aqueous solution and to inhibit the quick protonation of the anion intermediate formed in

the reaction process to give propionitrile. (2) The use of anion exchange membrane as electrolytic membrane, whose functions are as follows:

(a) to inhibit the transfer of p-toluenesulfonate anion to anode chamber so that the loss of coelectrolyte is prevented; (b) to keep oxidation reaction from occurring in anode chamber; (c) to let proton migrate from anode to cathode chamber so that the pH of cathode chamber is maintained and the source of proton needed for cathodic reduction reaction is guaranteed. If the pH of cathode chamber is not maintained and changes occur during the electrolytic process, side reactions would take place to form undesirable side-products. The current efficiency and yield of this reaction are approaching 100 percent. Figure 2 illustrates the electrolytic reaction.

Figure 2. Schematic Diagram of Adiponitrile Preparation by Dimerization of Acrylonitrile through Electro-reduction.



#### 4. Others

Other applications of ion exchange membrane as electrolytic membrane include the electro-reduction of uranium,<sup>11</sup> the preparation of sodium chlorite, the preparation of weak acids and bases, the synthesis of long chain binary acid<sup>12</sup> and even the gas phase electrolysis.<sup>3</sup> They will not be discussed.

#### V. The Current Status and Future Prospect of Organic Membranes

From the above-mentioned examples, the superiority of organic over inorganic membranes as electrolytic membrane can be clearly seen. They either improve the electrolysis technology, lower electricity consumptions and increase yields or make possible reactions that are not feasible under ordinary conditions. However, the research and production aspects of organic membranes in our country lags behind the need for the development of electrosynthesis industry. The few available organic membranes are listed in Table 3. With the advancements of inorganic and organic electrosynthesis technologies, it is inevitable that new requirements of membrane will be brought forth, particularly membranes will be required to possess altogether the features of resisting chemical corrosion,

anti-oxidation, long useful life and permselectivity toward specific ions. On the other hand, the development of organic membranes will stimulate advancements of electrolytic industry. It can be anticipated that new situations will emerge in the research and production of organic membranes.

Table 3. Some Organic Membranes Currently in Production

<u>Type</u>	<u>Material</u>	<u>Properties</u>	<u>Produced By</u>
F-101	Polyvinylidene Fluoride	acid resistant, not base resistant, antioxidation, permselective of cations	Jiangyang No 1 Chemical Plant, Zhejiang
F-201	same as above	acid resistant, not base resistant, antioxidation, permselective of anions	
P-102	Polyphenylether	acid resistant, base resistant, poor anti-oxidation, permselective of cations	Huzhou Chemical Plant, Zhejiang
E-105	Polyethylene	acid resistant, base resistant, moderate antioxidation, permselective of cations	Huzhou Chemical Plant, Zhejiang

#### FOOTNOTES

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APPLIED SCIENCES

EFFECT OF AMPLIFIED SPONTANEOUS EMISSION ON SPACE COHERENCE OF XeCl LASER

Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 12, No 5,  
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5358], Chen Jianwen [7115 1696 2429]

[Text] I. Introduction

Amplified Spontaneous Emission (ASE) is the single-pass wave amplification caused by the propagation of spontaneous emission through a stimulated medium which has already reached the state of particle number reversal.

Since Bloom first observed in 1963 the ASE output from a pulse He-Ne laser with no cavity mirror, several researchers have conducted both theoretical and experimental studies on amplified spontaneous emissions. But so far no systematic studies have been reported on the effect of ASE on the output characteristics of excimer laser; such effect is clearly important in high-gain excimer systems. The purpose of this article is to explore this particular issue.

II. Experimental Set Up

In this experiment, an ultra-violet, pre-ionized, Blumlein rapid-discharge, lateral excitation XeCl laser is used; its structure is described in Reference 1. In order to study the effect of ASE on the output characteristics of XeCl laser under different cavity Q values (expressed in terms of the reflectivity R of the cavity output mirror), an outer half-cavity structure is used. The aft cavity mirror is a film-coated fully-reflecting flat mirror which is sealed directly onto the laser gas chamber; the forward cavity mirror is located on the adjusting frame so it can be easily replaced. The reflectivities of the forward cavity mirror are respectively 8 percent, 70 percent, and 92 percent. If the forward cavity mirror is removed, then it becomes a cavity-less device.

We used a typical Young's double-slit interference experiment to determine the spatial coherence between the XeCl laser and the ASE. The optical path of the experiment is shown in Figure 1.

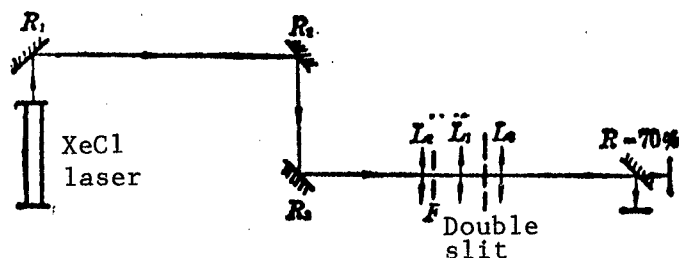


Figure 1. Optical Path of Young's experiment

$R_1$ ,  $R_2$  and  $R_3$  are mirrors with reflectivities of 70 percent, 4 percent and 100 percent respectively.  $L_1$  and  $L_2$  are positive lenses with focal lengths of 30 cm and 10 cm respectively; together with the diaphragm they form a simple broad-beam telescope system. A 2m-focal length positive lens is placed behind the double-slit to provide Fraunhofer's condition.

The double-slit used in the experiment is 0.1 mm wide and 20 mm long, with a length to width ratio of 200:1; therefore, the length of the slit can be regarded as infinite compared to the width. The separation distance between the slits is chosen to be 0.5 mm, 1.0 mm, and 2.0 mm respectively.

The operating conditions of the laser are: pre-ionization voltage--28.3 kV, main discharge voltage--18.4 kV. The composition of the medium is: HCl:Xe:Ne = 3 Torr: 25 Torr: 2.5 atm.

To analyze the effect of differences in exposure intensity of the photographic plates on the visibility of interference fringes, we installed a spectroscope with  $R=70$  percent in front of the image screen. This allows taking two simultaneous photographs of each light pulse with different exposure intensities for comparison. Figure 2 shows the blackness curves of the interference pattern for the case where the reflectivity  $R$  of the cavity output mirror is 92 percent and the distance between the double slit is 0.5 mm. It is clear that the visibility of the interference fringes with weaker exposure intensity (30 percent) is better than the case with stronger exposure intensity (70 percent).

[Figure 2 on following page]

In Reference 2, it was pointed out that the output intensity of the XeCl laser is a function of the reflectivity  $R$  of the forward cavity mirror. Because of instability in the Blumlein rapid-discharge, lateral excitation type equipment, it is very difficult to achieve uniform light intensity. For this reason, we designed an experiment to explore the possibility of converting between exposure intensity and visibility. The optical path of this experiment is shown in Figure 3, where  $R_4$  and  $R_5$  are spectroscopes with reflectivities of 92 percent and 70 percent respectively. This allows us to take three simultaneous photographs of the interference pattern, and to determine the relationship between the maximum intensity ( $I_{max}$ ) and minimum intensity ( $I_{min}$ ) under different exposure conditions. The results are shown in Figure 4.

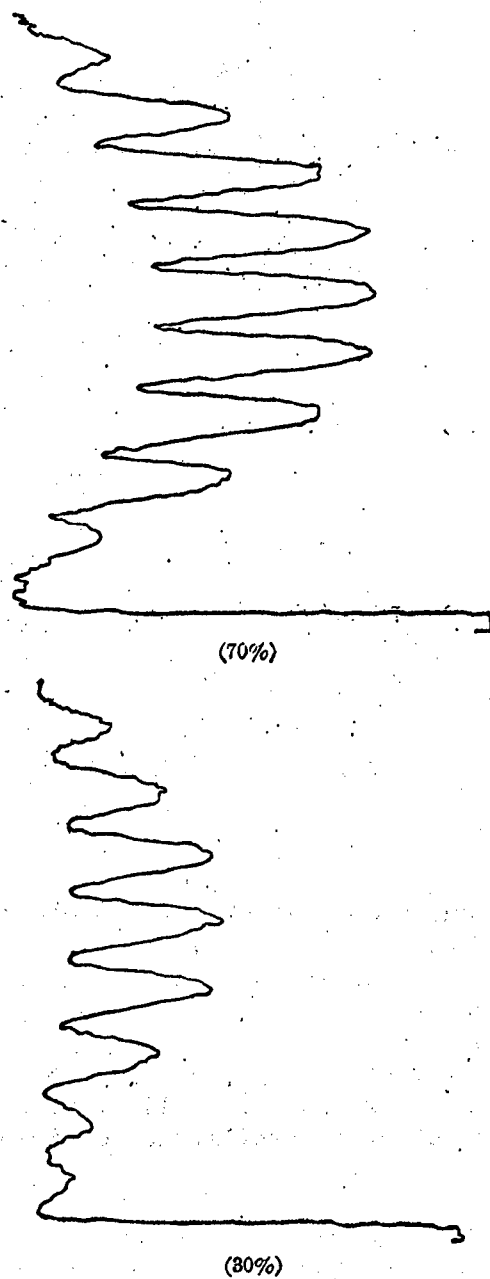


Figure 2. Blackness Curves of the Interference Pattern

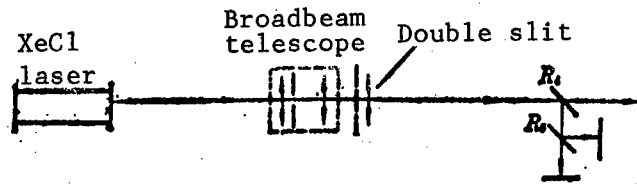


Figure 3. Optical Path of the Equivalent Light Intensity Conversion Experiment

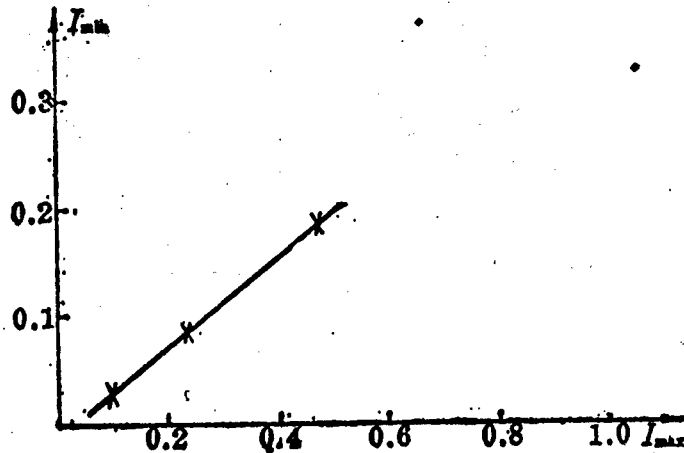


Figure 4. Relationship Between  $I_{\min}$  and  $I_{\max}$

The results of this experiment show that when the photographic plate is operating in the linear region, variations in light intensity of the interference pattern vary linearly with exposure intensity. On this basis, we can convert patterns under different intensities into patterns which correspond to a standard light intensity and compare against one another; thus the equal light intensity requirement is satisfied. The advantages of using the light intensity-visibility conversion is two fold: 1) it simplified the experiment, and 2) it eliminates the effect of instability of equipment operation.

The experimental procedure is as follows. For a given slit separation, interference patterns are taken under different Q value conditions, then the slit separation is changed and the above procedure is repeated.

The base plate used in this experiment is an ultra-violet type II photographic plate; its developing and fixing times at 22°C are respectively 1 min. and 15 min.

When the light intensity  $I_1$  through slit 1 is equal to the intensity through slit 2, the intensity distribution on the image screen is<sup>[3]</sup>

$$I = 2b^2 \sin^2 \frac{kbx}{2f} \left[ 1 + |\mu_{12}| \cos \frac{kdx}{f} \right] \quad (1)$$

where  $k$  is the average wave number,  $b$  is the slit width,  $d$  is the slit separation, and  $f$  is the distance between the double slit and the screen.  $|\mu_{12}|$  is given by:

$$|\mu_{12}| = \frac{I_1 + I_2}{2\sqrt{I_1 I_2}} W \quad (2)$$

It is the mode of the complex coherence of the partially coherent light,  $W$  is the visibility of the interference fringes, and  $I_1, I_2$  are respectively the intensities through the two slits.

The above calculations show that the number of interference fringes  $n$  within the zeroth order diffraction envelope is

$$n = 2 \frac{d}{b} - 1$$

When  $d/b = 5, 10,$  and  $20,$   $n$  is  $9, 19,$  and  $39$  respectively. Figure 5 (a) and (b) respectively show the intensity distributions within the zeroth order diffraction envelope which correspond to the conditions  $R=92$  percent,  $d=0.5$  mm and  $d=1.0$  mm. The dash lines are the theoretical diffraction envelopes based on equation (1).

[Figure 5 on following page]

Under different  $Q$  value conditions, the variation of  $|\mu_{12}|$  with slit separation is given in the following table.

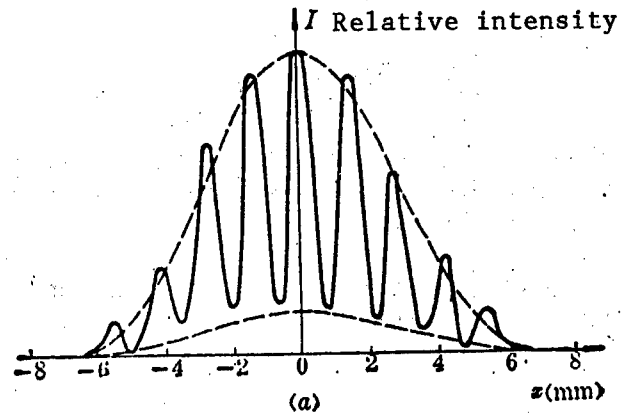
$d \backslash R$	8%	70%	92%	ASE
0.5 mm	0.77	0.93	0.78	0.61
1.0 mm	0.48	0.68	0.49	0.42
2.0 mm	0.29	0.55	0.36	0.13

These results show that when other conditions are fixed, the degree of coherence of the XeCl laser has a maximum with respect to variations in  $R$ .

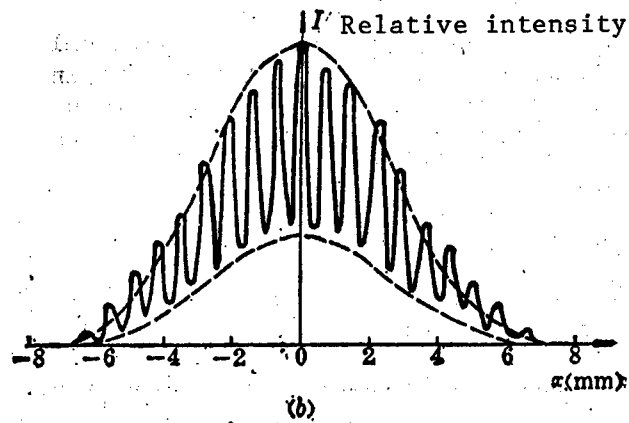
### III. Discussion

1. In the case of a metastable cavity such as the parallel-planar cavity, if the base mode laser field is treated as an axial beam and the remaining higher order mode laser fields are treated as non-axial beams, then the relative energy loss between the two is<sup>4</sup>:

$$\Delta\delta = \frac{t\theta/a}{1-R} \quad (4)$$



$d=0.5\text{ mm}$



$d=1.0\text{ mm}$

Figure 5. Light Intensity Distributions Within the Zeroth Order Diffraction Envelope

where  $l$  is the length of the cavity,  $a$  is the radius of the cavity mirror, and  $\theta$  is the angular deviation of light beam from the axial direction. Clearly, the larger  $\Delta\delta$  is, the less likely that resonance of the higher order lateral modes will occur. The above expression shows that once the geometric structure of the cavity is fixed, the relative energy loss  $\Delta\delta$  is determined by the reflectivity of the cavity output mirror R. As R increases,  $\Delta\delta$  also increases. If the spatial coherence of an XeCl excimer laser is primarily determined by the lateral mode structure, then the degree of coherence  $|\mu_{12}|$  should be higher when a high-reflectivity cavity mirror is used. In other words,  $|\mu_{12}|$  should increase monotonically with R. However, this does not agree with our experimental results. For this reason, we believe that in the case of a high-gain excimer system with multiple lateral modes, while the higher order modes can be partially suppressed by increasing the reflectivity of the cavity output mirror, it has little effect on spatial coherence.

2. In the Yong's experiment, if the effect of single-slit diffraction is neglected, then the intensity at any point on the screen  $I(Q)$  can be expressed as

$$I(Q) = I_1 + I_2 + 2\sqrt{I_1 I_2} |\mu_{12}| \cos \delta \quad (5)$$

where  $\delta$  is the phase difference between the two light beams reaching the point Q through the two slits  $P_1$  and  $P_2$ .

The above expression can be rewritten as

$$I(Q) = |\mu_{12}| \{I_1 + I_2 + 2\sqrt{I_1 I_2} \cos \delta\} + \{1 - |\mu_{12}|\} (I_1 + I_2) \quad (6)$$

where the first term on the right side of the equation can be regarded as the coherent addition of two light beams with intensities  $|\mu_{12}|I_1$  and  $|\mu_{12}|I_2$  and relative phase difference  $\delta$ ; the second term can be regarded as the non-coherent addition of two beams with intensities  $(1 - |\mu_{12}|)I_1$  and  $(1 - |\mu_{12}|)I_2$ . Therefore, the total intensity of the light source can be expressed as

$$I_{\text{total}} = I_c + I_{\text{nc}} \quad (7)$$

where  $I_c$  and  $I_{\text{nc}}$  represent the intensities of the coherent light and non-coherent light respectively. Furthermore,

$$\frac{I_c}{I_{\text{nc}}} = \frac{|\mu_{12}|}{1 - |\mu_{12}|} \quad (8)$$

thus,

$$|\mu_{12}| = I_c / (I_c + I_{\text{nc}}) \quad (9)$$

Assuming that the output of the XeCl excimer laser contains purely excited emissions, i.e., laser and ASE, then the total output intensity can be expressed as the sum:

$$I = L + S \quad (10)$$

where L and S represent the intensities of the laser and the ASE respectively; also

$$\begin{aligned} I_c &= L_c + S_c \\ I_{nc} &= L_{nc} + S_{nc} \end{aligned} \quad (11)$$

It follows that the mode of the complex degree of coherence is:

$$|\mu_{12}| = |\mu_{12}|_L \frac{L}{L+S} + |\mu_{12}|_S \frac{S}{L+S} \quad (12)$$

where

$$\begin{aligned} |\mu_{12}|_L &= L_c/L \\ |\mu_{12}|_S &= S_c/S \end{aligned} \quad (13)$$

Considering the fact that the intensity of coherent light  $I_c$  is proportional to the photon flux  $\phi_{st}$  of the excited emission and the intensity of non-coherent light  $I_{nc}$  is proportional to the photon flux  $\phi_{sp}$  of the spontaneous emission, it is reasonable to assume that the laser contains only photons from excited emission, hence  $|\mu_{12}|_L \approx 1$ . However, the ASE contains not only photons from excited emission, but also from spontaneous emission within the solid angle  $d\Omega/4\pi$ , hence  $|\mu_{12}|_S$  is always less than 1. Under these conditions, the degree of coherence of the XeCl laser output  $|\mu_{12}|$  can be approximated by:

$$|\mu_{12}| \approx 1 - \frac{1}{\beta} (1 - |\mu_{12}|_S) \quad (14)$$

where

$$\frac{1}{\beta} \equiv \frac{S}{L+S} \quad (15)$$

It represents the relative proportion of ASE in the total output.

Since  $|\mu_{12}|_S$  is determined by the photon flux of spontaneous emission within the solid angle  $d\Omega/4\pi$ , which depends on the composition of excited medium, the excitation voltage, and the geometric structure of the cavity, once these conditions are determined, the magnitude of  $|\mu_{12}|$  will vary in proportion to

$1/\beta$ , as indicated in the above equation. In this respect, equation (14) can be regarded as one which describes the effect of amplified spontaneous emission on the spatial coherence of the XeCl laser. Qualitatively speaking, the larger the cavity Q value, the stronger the feedback on the photons, and the weaker the amplified spontaneous emission. On the other hand, there exists an optimum reflectivity value  $R_{opt}$  which corresponds to maximum output; when  $R > R_{opt}$ , the output intensity of the XeCl laser will decrease with increasing R. Therefore, the value of  $1/\beta$  can be minimized by choosing a particular value of R,  $R_0$ . In the vicinity of  $R_0$ , good spatial coherence of the beam is achieved; when R deviates from  $R_0$ , the coherence degrades accordingly. This is in agreement with the experimental results described above.

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3012

CSO: 4008/371

APPLIED SCIENCES

FIRST DOMESTIC HIGH REPETITION RATE ULTRASHORT PULSE LASER

Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 12, No 5,  
20 May 85 p 278

[Article by Guang Lin [1639 7190]]

[Text] On 7 February 1985, certification tests were conducted on the "High Repetition Rate Ultrashort Pulse Laser" built by the Shanghai Institute of Optics and Fine Mechanics of the Chinese Academy of Sciences. Experts at the meeting pointed out that this was China's first prototype high repetition rate ultrashort pulse laser. Its performance is higher than that of similar lasers in this country and is comparable to the advanced standards of foreign products. The energy of the pulse train of this laser is greater than 8 mJ; its single pulse width is 32 ps; its pulse stability is  $\pm 2$  percent at 10 pps and  $\pm 4$  percent at 33 pps; and its mode-locked probability is 100 percent. The repetition rates are 10 pps, 20 pps, and 33 pps. The laser not only has a smooth pulse waveform, but its operation is stable and highly reliable.

The high repetition rate ultrashort pulse laser is a valuable tool in the study of ranging and spectral techniques; it can be used to improve the measurement accuracy of ranging devices on third-generation artificial satellites, and to increase the time resolution of laser spectral analysis.

3012  
CSO: 4008/371

APPLIED SCIENCES

PRACTICAL EXCIMER LASER DEVELOPED

Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 12, No 5,  
20 May 85 p 297

[Article by Qun Li [5028 5539]]

[Text] After nearly 3 years of research and continuous improvement of its experimental equipment, the Excimer Laser Group of the Shanghai Institute of Optics and Fine Mechanics has developed a practical excimer laser with the following properties: single pulse output energy 280 mJ, wavelength 3080 Å. Its repetition rate can be adjusted between 0-10 Hz, its average output power is 1 w, and its single-charge life exceeds  $10^5$  firings. The gas replacement equipment can operate at the following bands: ArF (1930 Å), KrF (2490 Å), N<sub>2</sub> (3371 Å), and XeF (3511 Å). This equipment is also structurally very simple, and can operate reliably over a long period. Its price is only one-fourth to one-fifth of similar foreign products. The above specifications of the equipment have passed certification on September 25, and small-scale production will begin soon.

This highly coherent ultra-violet source which has a constant average power is a useful tool for research in photochemistry, pump dye lasers, surface physics, and laser medicine.

3012  
CSO: 4008/371

APPLIED SCIENCES

A HIGH PRECISION RATE DYE LASER PUMPED BY A CuCl LASER

Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 12 No 7,  
20 Jul 85 pp 399-401, 394

[Article by Jing Chunyang [2629 2504 7122], Zhang Guiyan [1728 2710 3601],  
Wu Zhengliang [0702 2973 0081], Shu Juping [5289 5468 0988], Hu Qiquan [5170  
0120 6898], Ying Lifeng [3009 4539 1496] and Lin Fucheng [2651 4395 2052]  
of the Shanghai Institute of Optics and Fine Mechanics, the Chinese Academy  
of Sciences; manuscript received 14 Mar 84]

[Text] Abstract: Experimental results of several high  
repetition rate Rhodamine dye lasers pumped by a CuCl laser  
are presented. The laser radiation covers a wavelength range  
of 5630 Å to 6320 Å and has a maximum conversion efficiency  
of 33 percent.

Recently there has been considerable success in the pumping of dye lasers with  
a copper vapor laser.<sup>1,2</sup> In this paper we report experimental results of  
several broadband Rhodamine dye lasers pumped by a CuCl laser. The CuCl laser<sup>3</sup>  
used in our experiments has an average power of 2W, a tunable repetition rate  
of 12.5 kHz and the intensity ratio of the 5106 Å and the 5782 Å radiation is  
5:3. The two ends of the discharge tube are equipped with Brewster angle  
windows (part A in Figure 1) and the output is horizontally polarized. The  
main branch instability cavity has a beam divergence angle of 1 mrad. The  
selection of the yellow line or the green line is made with a dispersive  
triangular glass prism at one end of the total reflection mirror in the concave  
surface of the cavity.

Figure 1 shows the experimental apparatus. The triple-reflecting cavity contains  
spherical total reflecting mirrors  $M_1$  and  $M_2$  and a planar semi-reflecting  
mirror  $M_3$ . The reflecting mirrors are coated with a broadband total reflecting  
or semi-reflecting dielectric film with a center wavelength of 5850 Å. The  
distance between  $M_1$  and  $M_2$  is 10 cm, and the dye jet film C is located halfway  
in between. The distance between  $M_2$  and  $M_3$  is 30 cm and the length of the  
entire cavity is 40 cm. The distance between  $M_1$  and  $M_2$  is adjustable to match  
the spot size on the jet. The liquid film surface makes a Brewster angle with  
the optical axis. The jet is formed by a 0.4x5 mm nozzle and the jet speed is

60 m/min. A circulating pump drives the liquid dye solution. The power of the dye laser is measured with a model JGIII laser power meter P and the laser spectrum is measured with a model HRS-2 grating monochromator. The light beam of interest is diverted out of the main beam by a flat glass plate  $M_5$ .

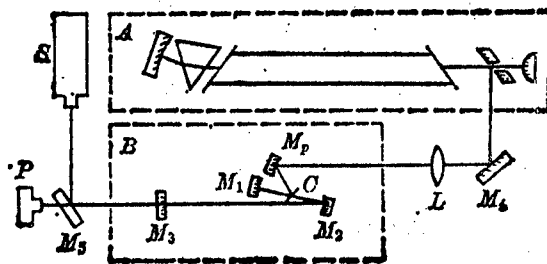


Fig. 1 Experimental Setup

A-CuCl laser, B-Dye laser, C-Dye jet film,  $M_p$ -Concave spherical reflector for pumping lights,  $M_1, M_2, M_4$  - Total reflection mirrors,  $M_3$  - Semireflecting mirror,  $R_1 = 5$  cm,  $R_2 = 10$  cm,  $R_3 = \infty$ , L - lens,  $M_5$  - Flat glass plate, P - Laser power meter, S - Grating spectrometer.

We studied the ethylene glycol solution of R6G, RB, and R640 + R6G. The optimum output coupling of the resonance cavity using a  $1 \times 10^{-3}$  mol R6G solution is  $T = 50$  percent and all the results reported here are obtained using such an output. We measured the dye laser output power and the laser efficiency as a function of the pumping power for R6G ( $1 \times 10^{-3}$  mol) and RB ( $1 \times 10^{-3}$  mol) and the results are presented in Figures 2 and 3. The lasing threshold of R6G pumped with only a green line is quite low (70 mW).

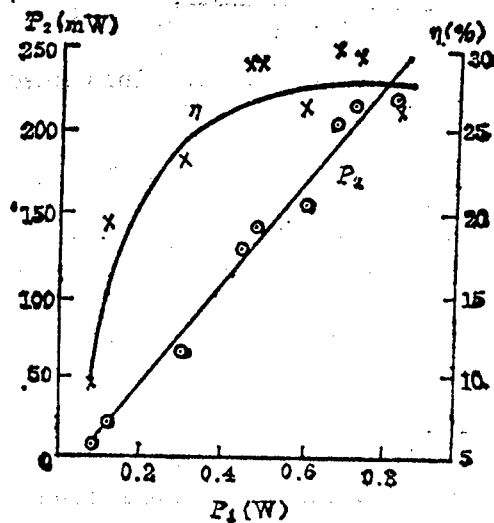


Fig. 2 Laser Power and Efficiency of R6G as a Function of the Pumping Power

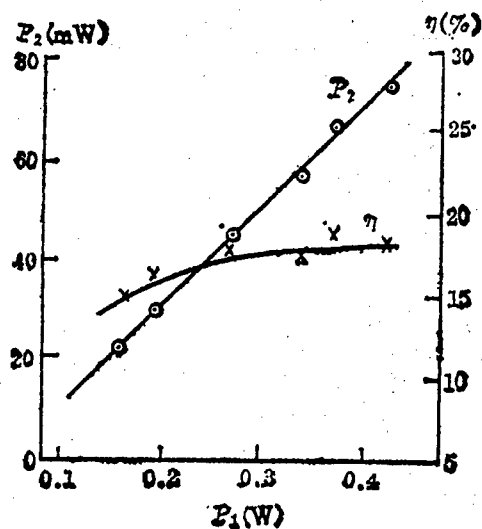


Fig. 3 Laser Power and Efficiency of RB as a Function of the Pumping Power

Within the measurement range, the dye laser output power depends linearly on the pumping power. The efficiency rises rapidly when the pumping power is increased from the threshold to 0.5 W. When the pumping power exceeds 0.5 W, the laser efficiency approaches a constant of 28.5 percent. Under optimum conditions the maximum power is 308 mW, the pumping power is 0.93 W and the efficiency is 33 percent. When the laser is pumped with a 1.2 W double wavelength light containing 0.75 W of green light, the output drops from 207 mW when the laser is pumped with a green light only to 116 mW. This indicates that the 5782 Å pumping light has a quenching effect on the R6G dye laser. The cause is that the amplification of the 5782 Å radiation along the optical axis eliminates the population inversion. Although the stimulated amplified pumping radiation of 5782 Å is coherent and has the same wavelength as the coherent oscillation of the dye laser at 5782 Å, since their propagation directions are different, the pumping light makes no contribution to the dye laser. Conversely, since the dye laser energy levels are uniformly broadened, the amplification of the 5782 Å pumping light depletes the population inversion and lowers the gain of the entire spectral line. This phenomenon is consistent with that reported in Reference 4.

Figure 3 shows the results of an RB laser pumped by the green light only. The efficiency increases when the pumping power is less than 0.25 W and becomes a constant 18 percent when the pumping power exceeds 0.25 W. The efficiency of the RB dye laser saturates at a lower value than the R6G dye. The output power of the RB laser is also linear with respect to the pumping power, the maximum output is 77 mW at a pumping of 0.42 W. Lasing is also obtained with a yellow line pump but the output is weak.

We have also studied R640 ( $1.5 \times 10^{-3}$  mol) + R6G ( $1.5 \times 10^{-3}$  mol). Lasing is obtained by using the green line, the yellow line, and both. The output is 40 mW and the efficiency is 9 percent using the full line pumping light.

Figure 4 shows the relationship between the stimulated emission intensity  $I$  of the dye and the wavelength  $\lambda$ . As a comparison, the center wavelength  $\lambda_c$ , the bandwidth  $\Delta \lambda$  and the cutoff wavelengths  $\lambda_1$  and  $\lambda_2$  determined from the graph are listed in Table 1. Also listed are the pumping wavelength  $\lambda_p$  and the lasing efficiency  $\eta$ . The cutoff wavelengths are taken at the 10 percent points of the maximum intensity.

The laser spectral bandwidth of the three ethylene glycol dye solutions ranges from 160 Å to 250 Å and the center wavelength shifts with experimental conditions (see Table 1).

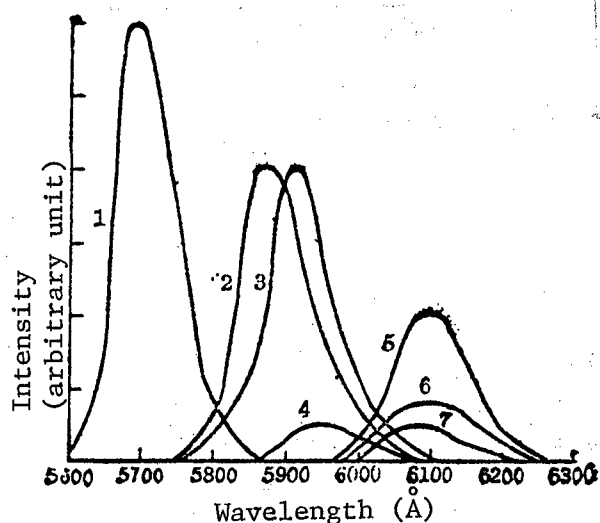


Fig. 4 Radiation Intensity of Dye Laser Verses Wavelength  
1 - R6G; 2,3,4 - RB; 5,6,7 - R640 +R6G

When the R6G dye is pumped with the 5106 Å line above, the center wavelength is at 5708 Å and the bandwidth is 160 Å (see curve 1 in Figure 4). The center wavelength of the RB dye pumped by the full line (curve 3) is only 36 Å greater than that pumped by the green line, and the output intensities are essentially the same. The center wavelength of the dye pumped by the yellow line is 5950 Å, 70 Å longer than that of the green line, but the intensity is much weaker.

To interpret the relationship between the stimulated radiation intensity and the pumping wavelength, we show the absorption spectra of the ethylene glycol solutions of the three dyes in Figure 5. As can be seen, for the RB dye, the relative absorption of the green pumping light is 7 times that of the yellow light. In our experiments the yellow pumping light is near the threshold and consequently the output is weak and the yellow line contribution in the full line pumping is also small. Within the measurement accuracy the output power shows no obvious difference between the green pump and the yellow pump.

Table 1

Dye	Concentration ( $\times 10^{-3}$ mol)	$\lambda$	$\Delta\lambda$	$\lambda_1 \sim \lambda_2$	%	$\lambda_p$ (Å)
		(Å)	(Å)	(Å)		
R6G	1	5708	160	5630~5790	28	5106
		5880	228	5788~6016	18	5106
RB	1	5916	204	5820~6024		5106 + 5782
		5950	200	5870~6090		5782
		6096	250	6000~6250		5106
R640	1.5	6096	200	6020~6220		5782
R640 + R6G	1.5	6096	220	6010~6230	9	5106 + 5782

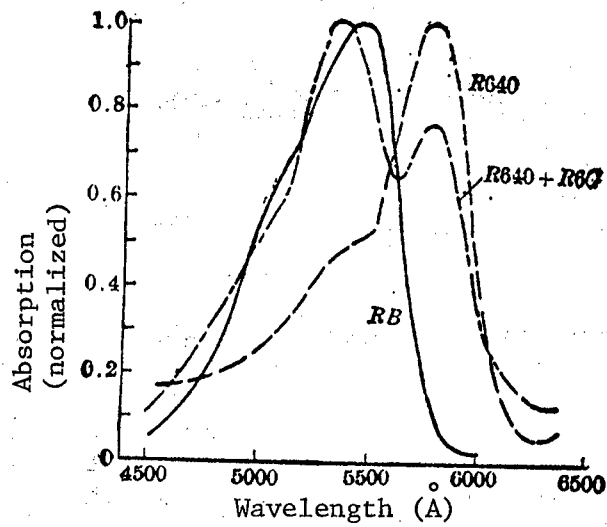
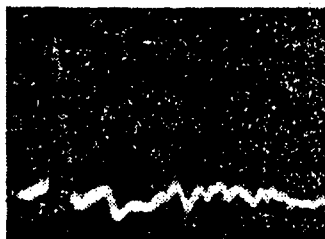


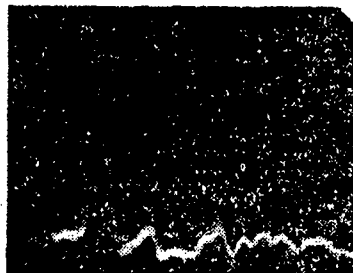
Fig. 5 Absorption Spectra of the Ethylene Glycol Solution of RB, R640, and R640 + R6G

The 640 (R640) Rhodamine dye has a high fluorescence quantum efficiency<sup>5</sup> in the red region, the fluorescence peak is at 6200 Å. Using R6G as the donor and R640 as the acceptor, we formed the mixed dye. The hope is that the absorption of the green pumping light will be increased and the output will be greater due to the energy transfer between the two dyes. It is also hoped that the fluorescence peak will shift toward shorter wavelength and join with the RB spectrum. Experimental result shows that the center wavelength of the R640 + R6G mixture is at 6096 Å. The center wavelength remains the same under the three pumping lights and only the intensity changes, decreasing in the order of full line, green line and yellow line (curves 5, 6 and 7 in Figure 4). By comparing the R640 curve and the R640 + R6G curve in Figure 5, one finds that the absorption of the green light of R640 has doubled by adding R6G, the absorption of the yellow light has decreased slightly, and the total absorption increased considerably. The increase in the full line pumping output indicates energy transfer between the two dyes and R640 plays the role of the acceptor.

The amplitude of the curves in Figure 4 represents the relative radiation intensity. The intensity ratio is 3:2:1 for the R6G dye (curve 1), RB dye (curves 2 and 3), and R640 + R6G dye (curve 5). The output of R6G is the strongest and the output of R640 + R6G is the weakest. The duty cycle of the CuCl pumping laser is 12.5 kHz in all the measurements above. Figure 6 shows the pulse shape, the pulse shape of R6G pumped at 5106 Å is shown in Figure 6(a) and the pumping pulse shape is shown in Figure 6(b). The half width of the R6G is 19 ns and the full width is 37 ns. The half width of the 5106 Å pulse is 18 ns and the full width is 44 ns. The maximum output peak power of R6G can thus be computed to be 1.3 kW and the corresponding pumping light peak power is 4 kW.



(a) R6G waveform



(b) 5106 Å waveform

Fig. 6 Pulse Waveforms (time scale 50 ns/div)

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9698

CSO: 4008/398

APPLIED SCIENCES

CHINA DEVELOPS MICRO-CONTROLLED CO<sub>2</sub> LASER PROCESSOR

Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 12 No 7,  
20 Jul 85 p 435

[Text] Laser processors are important laser processing equipment used in the phase transformation hardening of various metals and parts, laser coating, laser alloying, and laser microcrystalization. The development of a micro-controlled high-power CO<sub>2</sub> laser processor was assigned as a priority project for 1982-1983 by the State Council and the Shanghai Municipal Party Committee to be conducted as a joint effort of the Shanghai Institute of Optics and Fine Mechanics, the Shanghai Electric Welding Plant, and the Shanghai Electric Equipment Plant. An experimental prototype of the processor has now been built and tested for heat treatment such as the laser phase hardening, laser alloying, and laser coating and for laser welding, leading to satisfactory results. With additional accessories the processing capabilities will be expanded further.

The laser processor was certified in the certification meeting held in Shanghai on 30 and 31 March 1985. It is believed to be the first full-function laser processor built in China. The associated departments consider it highly important to promote the production of such processors and hope the intermediate testing production will be done well.

9698  
CSO: 4008/398

LIFE SCIENCES

HUMAN HEMODYNAMIC CHANGE UNDER HIGH ATMOSPHERIC PRESSURE

Beijing JIEFANGJUN YIXUE ZAZHI /MEDICAL JOURNAL OF CHINESE PEOPLE'S LIBERATION ARMY/ in Chinese No 1, 20 Feb 85 p 63

[Article by Zhang Hengdu /4545 1854 4648/ and Dai Duanyang /2071 4551 7122/ of the Naval Medical Research Institute: "Human Hemodynamic Change in Continuous Simulated 26-day Nitrogen-oxygen Saturation Dive at 36.5 Meters (Summary)"]

[Text] For the purpose of observing human hemodynamic change under high atmospheric pressure, we adopted nontraumatic means to record sphygmograms during a 26-day continuous nitrogen-oxygen saturation dive simulation trial at 36.5 m. The test subjects assumed a supine position and the sphygmogram was recorded on closed vessels on the left side using a mercurial sphygmomanometer to measure blood pressure in the arteria brachialis of the left arm. Based on the EO-0 Formula supplied by Nanchang 2d Hospital's Office of Sphygmology, the data from the initial measurements was processed through a Chinese Model 719 electronic computer. The voluntary test subjects were seven young males averaging 22.6 +/- 3.9 years of age. The simulated pressure measured 4.65 ATA, cabin temperature was 26.05 +/- 0.8°C and relative humidity measured 70.3 +/- 0.9 percent. Differential pressure measured 0.31 +/- 0.08 ATA for oxygen, 0.002 ATA for carbon dioxide and 4.34 ATA for nitrogen. The subjects lived and worked under the above conditions for 26 continuous days and nights and underwent 4 days of decompression to return to normal pressure.

The following results were made clear during the saturation retention period: Heart rates slowed and by the 5th day were still 12.8 percent slower than they were prior to the pressure increase. Stroke volume (SV) gradually increased and the hourly cardiac output (CO) remained basically unchanged or increased. By the 25th day SV had risen from 88.2 +/- 19.9 ml to 116.3 +/- 12.9 ml, CO had increased from 5.574 +/- 0.2071 to 7.455 +/- 0.0811 and the cardiac index had reached 4.331/min/m<sup>2</sup>. Average systolic pressure, diastolic pressure and arteriotony increased notably. At under 4.65 ATA the active blood volume in systemic circulation increased, as did the left ventricular end-diastolic volume and the left atrial blood volume. This indicates that under high pressure the anterior and posterior cardiac loads increase equally.

During the saturation retention period the following also occur: The dynamic bulk modulus (VE) of the left ventricle and the Young's modulus (EY) of the large arteries rise; the integrated coefficient of reflection (Etk) and the

degree of smoothness in the blood flow increase; and the ventricular volume and the vascular jet fractional feedback coefficient (VJK) are decreased. The VE and EY increases under high atmospheric pressure illustrate that during vascular jetting the cardiac muscle and the large arteries (under average arterial pressure) become stronger. The increase in Etk illustrates that the receptive reflex function to arterial blood pressure is a hyperfunctional state. The decrease in VJK illustrates that the adrenocortical function is a stress state. These factors are beneficial in increasing an organism's ability to adapt to an environment under high atmospheric pressure. The 17-hydroxycorticosterol in the urine of test subjects was in all cases higher than normal clinical values, and this fact supports the above point. The increase in stroke volume and integrated reflect coefficient, the rise in cardiac-muscle mechanical efficiency, the increased degree of smoothness in blood flow, the rise in the left ventricular momentum transport coefficient, the drop in heart rate and other changes help maintain satisfactory blood circulation in an organism's lungs, heart, brain and other major organs under high atmospheric pressure.

As the retention time lengthens, for the most part these changes that appear gradually approach control values. After the drop to normal pressure the indicators which change under high atmospheric pressure can also be restored to normal.

From this it is apparent that sphygmograms can rather comprehensively reflect the state of human hemodynamic change under high atmospheric pressure, and they are also superior to other nontraumatic means. They may be of help in studying regular patterns of hemodynamic change under specific physiological work conditions.

12510

CSO: 4008/297

4 September 85

## LIFE SCIENCES

## PROGRESS IN BIRTH CONTROL TECHNIQUES REPORTED

Beijing RENMIN RIBAO in Chinese 28 Feb 85 p 5

[Article by Xiao Bilian /5135 4310 5571/ : "Progress in Birth Control Techniques"]

[Text] China currently uses more than 10 birth control methods, and each type has its own unique variations in different locales. For example, there are more than 10 varieties of the intrauterine devices used most widely in China: the nationally most popular stainless steel loop, Guangdong's plastic "birth control flower," Tianjin's "twisted loop" (an articulated double loop), Shanghai's copper V-model, Zhejiang's copper T-model, Beijing's gold loop and Sichuan's shield model, as well as the ones currently under study, such as the magnetized metal IUD, the progestin-releasing IUD or the hemostatic IUD, and so forth. China is first internationally in terms of the proliferation of varieties. Moreover, we are superior to the European and American nations in other methods such as steroid contraceptive research and sterilization operation techniques.

The IUD is relatively well-accepted because it is easily inserted, has a long service life and is safe and effective. The problem is that menstrual flow increases after the insertion of the IUD, so research into the hemorrhagic mechanism and ways to decrease the amount of postinsertion hemorrhaging are very important questions for study. The major cause for the increase in menstrual flow is the local effect of the IUD on the uterine lining. In order to resolve the hemorrhage problem, the U.S. Aiza Pharmaceutical Plant developed the progesterone-releasing T-model IUD in the 1970's. This model uses a mixed ethyl acetate macromolecular compound as the raw material and contains 38 mg of progesterone. It releases 65 micrograms per day and, due to the local effects of the progesterone on the uterine lining, hemorrhaging is notably reduced. It is capable of reducing the menstrual flow by half. However, due to limits on progesterone content, the IUD can only remain in place for something over a year. If it must be replaced each year it loses the advantages of long-term effectiveness. In the past few years, the World Health Organization has switched to 18 $\beta$  norethindrone, releasing 2 micrograms per day, and this can be maintained for 10 years. Here in China, Guangdong, Shanghai and Tianjin are also studying this type of IUD.

Steroid contraceptives have been under development in China for nearly 20 years. Beginning from the one-pill-per-day short-term oral contraceptive, we

have developed diverse types of injections, long-term oral pills, /tanqin 2232 6024/ pills, day-after pills, vaginal loops and oral contraceptives from various pharmaceuticals. At present, in China and abroad the research trend is toward low dosage, slow release and long-term effectiveness. The U.S. National Institute of Health has adopted polycapro and developed a slender tube containing medication that is implanted under the skin. It released 20-40 micrograms of 180 norethindrone per day and can be maintained for a year. The advantages of these preparations are that the dosage is small, longlasting and safe. Their major defect is that some women may experience spotting.

There has been a great deal of epidemiological investigation and research both here and abroad on the safety of long-term steroid contraceptive use. There have been a great many reports particularly concerned with metabolism, cardiovascular disease, tumors and induced congenital malformations. From the perspective of long-term safety, use of a slow-release, low-dosage steroid hormone contraceptive is quite reasonable. Microcapsule injections, subdermal implants, and vaginal loops are all contraceptives of this type.

Research into male reproductive physiology is a new branch of learning on the interantional front, and we have initiated studies of this subject domestically in the last 3-4 years. Except for vasoligation and the external use of spermaticides and prophylactics there are still no other popular male methods of birth control used abroad. The male gossypol oral contraceptive is China's own original creation. Its contraceptive effects have been confirmed but there are some side effects that remain to be studied and improved.

Interference with the production of progesterone in the latter half of the menstrual cycle, making the uterine lining an unsuitable bed for the receipt of the fertilized egg or causing it to abort in the first 30-plus days of pregnancy, is an ideal way of preventing fertility. There are many scientists engaged in research in this area both in China and abroad.

Research progress on contraceptive medicines and tools and on birth control operations has been very rapid, but it is still insufficient for the needs of the masses. The masses demand birth control measures that are perfect in every way and absolutely safe. However, it must be understood that the human reproductive function is a normal physiological phenomenon. The purpose of any contraceptive medicine, tool or operation is to interfere with this physiological phenomenon or to obstruct some link in the process. Consequently, the possibility of producing some side effect is unavoidable, though it will not necessarily affect one's health. In the wake of modern scientific and technological developments and a progressively more thorough understanding of reproductive physiology, we are convinced that in the near future scientific and technological workers will find better, more ideal channels of contraception.

12510  
CSO: 4008/297

## SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

### HEFEI BRANCH OF CAS DESCRIBED AS BURGEONING 'ISLAND OF SCIENCE'

Hefei ANHUI HUABAO in Chinese No 1, 1985 pp 6-7

[Excerpts] An hour's automobile ride to the west of the city of Hefei will bring one to an "island of science"--The Hefei branch of the Chinese Academy of Sciences located on the Dongpu Peninsula on Lake Shushan.

Measuring some 7 li from east to west and 3 li from north to south, this "island of science" focuses its research on technical physics. The island sports four imposing research buildings, three tastefully designed buildings overlooking the lake (converted to laboratories), and auxiliary buildings, schools, and shops. Living quarters for the staff and workers are dispersed among the other buildings.

The area was once a uninhabited island thickly covered with bushes and trees. Construction began in 1960 and in 1978, after the Hefei Branch Academy had been established there, being built from what had once been the Anhui Institute of Optics and Fine Mechanics, it became a plasma physics research institute, a solid physics research institute, and a robot research institute. Scientific and technical personnel of the four institutes now comprise something more than 50 percent of the more than 2,300 staff and workers. They include 30-odd senior research personnel and more than 500 assistant researchers and engineers. The noted metal physics expert Ge Tingsui and middle-aged scientists Huo Yuping, Li Fenglou, Liu Songhao, Qiu Lijian, Gu Zhiyu, and others are all members of this branch academy.

More than 300 pieces of advanced instruments and equipment have been purchased as well as 30,000 processing machine tools; more than 20 modern laboratories have been built.

The four research institutes of the Branch Academy are principally engaged in research on lasers, new energy sources, new materials, and other areas, in support of both national economic and defense construction. The Anhui Institute of Optics and Fine Mechanics, built in 1970, is the "big brother" among the four research institutes. Its objective is to conduct applied research in laser spectroscopy and technology, atmospheric optics and remote sensing. It has already developed more than 100 research tasks, and has chalked up achievements in more than 70 areas for which 30-odd awards have been made by the State Science and Technology Commission, the National Defense Science

Committee, the Academy of Sciences, and Anhui Province. The Plasma Physics Institute grew out of the Anhui Institute of Optics and Fine Mechanics in 1978. Its primary work involves experimental and theoretical research and development in high temperature plasmas, plasma physics, controlled thermonuclear fusion research and the development of controlled thermonuclear fusion engineering. In a word, to tap the oceans for new energy sources, to meet the demands for man's future social and production development. The Robot Research Institute grew out of a division of the Hefei No 1 Radio Plant in 1979. Its primary work is in testing and measurement, stressing research in sensor [transducer] technology, robots, mechanical manipulators, and other research in automation and control. In recent years this institute made a dozen or so scientific achievements of outstanding benefit to the national economy. The Solid Physics Institute's primary research target is new structural materials, although it also explores flaws and mechanical properties [of solids]. Institute head Ge Tingsui, although now past 70, still is vigorous. In addition to his leadership responsibilities, he also undertakes basic theoretical and some other research of major economic importance.

Premier Zhao Zhiyang pointed out that "economic construction relies on science and technology and science and technology must gear itself to economic construction." In this S&T guideline, the newly constructed "island of science" plays a major role in the development of China's economy. Today, the island is a scene of intense construction activity and a number of new projects are soon to be completed.

CSO: 4008/404

Applied Mathematics

AUTHOR: WENG Wenhui [5040 2429 6540]  
ORG: Department of Computer Sciences, Xiamen University  
TITLE: "The Countable Decomposition Theorem of Fuzzy Subspaces"  
SOURCE: Xiamen XIAMEN DAXUE XUEBAO (ZIRAN KEXUE BAN) [JOURNAL OF XIAMEN UNIVERSITY (NATURAL SCIENCE)] in Chinese Vol 24 No 1, Jan 85  
pp 20-25

ABSTRACT: In [1], a Representation Theorem for fuzzy subspace in an infinite dimensional linear space is established. In this paper, we present an interesting special case for this theorem, that is, if a suitable topology on linear space is given, the formulation in the above theorem can be taken in countable decomposition form. The main result is:

Theorem: Let  $X$  be an infinite dimensional linear topological space, with non-Hausdorff property  $\{\theta\} \neq \{\theta\}$  ( $\theta$  the origin in  $X$ ), and  $F$ , the fuzzy set of  $X$ , of which the membership function  $\mu_F: X \rightarrow [0,1]$  is upper semicontinuous in  $X$ . Then  $F$  is a fuzzy subspace of  $X$  if and only if there exists a decreasing sequence chain  $\{\beta_n | n = 0, 1, 2, \dots\}$  in  $[0,1]$ , and a strictly increasing linear subspace chain  $\{X_n | n = 0, 1, 2, \dots\}$  in  $X$ , such that  $F$  can be uniquely expressed by

$$F = \bigcup_{n=0}^{\infty} \beta_n \cdot X_n$$

where  $\beta_n \cdot X_n$  is a fuzzy set of  $X$ , with membership function

$$\mu_{\beta_n \cdot X_n}(x) = \begin{cases} \beta_n, & x \in X_n, \\ 0, & x \in X \setminus X_n. \end{cases}$$

- REFERENCES: [1] 翁文辉, 厦门大学学报 (自然科学版), 21(1982), 371.
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CSO: 4009/1071

Applied Mathematics

AUTHOR: WANG Renzhi [3769 0088 2535]

ORG: Department of Physics, Xiamen University

TITLE: "Calculation of the Lowest Direct and Indirect Band Gap of  $Ga_{1-x}Al_xAs$ "

SOURCE: Xiamen XIAMEN DAXUE XUEBAO (XIRAN KEXUE BAN) [JOURNAL OF XIAMEN UNIVERSITY (NATURAL SCIENCE)] in Chinese Vol 24 No 1, Jan 85 pp 41-49

ABSTRACT: The zone-variational method is used to study the lowest direct and indirect band-gap of  $Ga_{1-x}Al_xAs$  as a function of composition,  $x$ . In this calculation, the potential inside each of the atom spheres in alloy is assumed to be spherically symmetric; the average value of the logarithmic derivatives of the radial wave functions is used at the sphere surfaces; the approximation of the virtual-crystal potential is used outside spheres. The results obtained agree quite well with experimental results.

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CSO: 4009/1071

AUTHOR: XU Mingyou [1776 2494 0645]

ORG: None

TITLE: "General Ideas and Common Formulas for the Equivalent Initial Disturbance"

SOURCE: Beijing BINGGONG XUEBAO [ACTA ARMAMENTARII] in Chinese No 2, May 85 pp 20-25

TEXT OF ENGLISH ABSTRACT: Beginning with general mechanical ideas, this paper deals with the effects on rocket motion caused by periodic disturbing factors and summarizes all the periodic disturbing factors into two kinds of functions,  $f_1(t)$  and  $f_2(t)$ , thus obtaining the two equivalent initial disturbances--the equivalent initial deflection and the equivalent mallaunching. This paper gives these two common formulas of the equivalent initial disturbances. One is the transformation coefficient  $K_e \cdot f_1(t_0)$ ; the other is  $K_e \cdot f_2(t_0)$ . Here  $K_e$  is not only suitable for all kinds of spin rockets, but also its expression is very simple. This expression form is very convenient for analyzing and calculating dispersion.

AUTHOR: MA Qingyun [7456 1987 0061]  
et al.

ORG: None

TITLE: "The System of Timely Measurement of Burn Rates of Solid Propellants  
by Line Scan"

SOURCE: Beijing BINGGONG XUEBAO [ACTA ARMAMENTARII] in Chinese No 2, May 85  
pp 26-31

TEXT OF ENGLISH ABSTRACT: With the emergence of microcomputers and the application of line scan cameras, it is possible for us to link these two modern instruments to measure the burn rate and combustion process of solid propellants by a new rapid photo-electric method. In this paper, the instantaneous optical image of the combustion process of two propellants, A and B, is transformed to numerical signals by a CCD line scan camera. Then the signals enter a PS-80 microcomputer and are stored in its memories. We can obtain the figure of pellet length versus time by the plotter, the average burn rate and pressure exponent, and various data tables by the printer. All data can be stored on tapes.

AUTHOR: ZHOU Zhou [0719 5297]  
et al.

ORG: None

TITLE: "Studies of the Dynamic Mechanical Properties of the Composite Modified Double-base Propellant"

SOURCE: Beijing BINGGONG XUEBAO [ACTA ARMAMENTARII] in Chinese No 2, May 85  
pp 49-58

TEXT OF ENGLISH ABSTRACT: The dynamic mechanical properties of the composite modified double-base (CMBD), double-base (DB) and polyvinyl chloride (PVC) composite propellants were measured respectively with a Rheovibron visco-elastometer. The effects of three kinds of solid fillers [aluminum (Al), ammonium perchlorate (AP) and cyclotetraethylenetetranitramine (HMX)] and different kinds and contents of plasticizers [triacetin (TA), ortho-dibutyl phthalate (DBP) and nitroglycerine (NG)] on the dynamic mechanical properties of the double-base binder were studied. The dynamic mechanical data and spectrums on these ingredients have been obtained at a fixed frequency (3Hz) and a broad temperature range. At the same time, the impact strengths of the CMBD propellant, the double-base binder and the PVC propellant were also measured at a broad temperature range. Experimental conclusions have been drawn that the dynamical mechanical properties of the CMBD propellant lie between the DB and PVC composite propellants and depend on the binder system, and that the CMBD propellant has the specific properties of both higher mechanical damping and a strong  $\beta$  relaxation at low temperatures.

AUTHOR: ZHANG Shouzhong [1728 1343 0022]  
et al.

ORG: None

TITLE: "Deformation and Rupture of Rigid Plastic Cylinder Shell Due to  
Explosion"

SOURCE: Beijing BINGGONG XUEBAO [ACTA ARMAMENTARII] in Chinese No 2, May 85  
pp 59-65

TEXT OF ENGLISH ABSTRACT: Development of deformation and rupture for a cylinder shell under high pressure explosion loading is very important in dealing with the direct accelerating and kill effect of the shell. This paper assumes the shell material is rigid and perfect plastic. The stress field, deformation speed, breaking radius and fragment velocity are approached. A comparison with experimental data has been made for 50 kinds of copper shell and 11 kinds of steel shell filled with various explosives. All the results are in good agreement with the data. The relative deviations are about 3 percent. The new model is suitable for engineering calculations.

9717  
CSO: 4009/270

AUTHOR: LUO Qingyao [5012 1987 1031]  
LEI Zhihong [7191 1807 3163]  
YU Ximao [0151 1598 5399]

ORG: Chemistry Department, Wuhan University

TITLE: "The Color Reaction of Rare Earth with Arsenazo-DBS and Its Application"

SOURCE: Changchun FENXI HUAXUE [ANALYTICAL CHEMISTRY] in Chinese Vol 12 No 11, 20 Nov 84 pp 985-988

TEXT OF ENGLISH ABSTRACT: A new chromogenic reagent, 3-(2-arsenophenylazo)-6-(2,6-dibromo-4-sulphophenylazo)-4,5-dihydroxy-2,7-naphthalenedisulfonic acid (arsenazo-DBS), can form complexes with cerium sub-group elements instantaneously in a strong acid medium with oxalic acid as a masking agent for heavy rare earth elements. Both the reagent and complexes are stable and their absorption maxima are 532 nm and 630 nm respectively. The color reaction has high sensitivity (for light rare earth  $\epsilon_{630} = (1.06-1.23) \times 10^5 \text{ l}\cdot\text{mol}^{-1}\cdot\text{cm}^{-1}$ ) and good selectivity. The quantity of the tolerance of many metallic ion interferences is in milligram order. Beer's law is obeyed in the concentration range of 0 to 12  $\mu\text{g}$  per 25 ml. The contents of light rare earths in aluminum alloys, nodular cast iron, low alloy steel and some high alloy steel samples can be determined directly, as can those of artificial samples of magnesium alloy and nickel alloy, with satisfactory results. (Paper received on 26 September 1983.)

AUTHOR: MA Zhizhong [7456 3112 0022]  
HE Jianling [0149 0256 3781]  
ZHOU Taijin [0719 3141 6930]

ORG: Guangxi Institute of Chemical Engineering

TITLE: "Background Correction in Atomic Absorption Spectrometry with Self-absorption Effect"

SOURCE: Changchun FENXI HUAXUE [ANALYTICAL CHEMISTRY] in Chinese Vol 12 No 11, 20 Nov 84 pp 992-996

TEXT OF ENGLISH ABSTRACT: A strong and weak current pulse were alternately applied on the same hollow cathode lamp, with the sharp line of weak current pulse as the measurement beam and the self-absorption line of strong current pulse as the reference beam, resulting in correcting the background through their absorbance difference. A microprocessor was used to process the real-time data. Accurate correction of the background absorption is achieved on the same hollow cathode lamp at the same time and wavelength as the atomic absorption line. The flame fluctuation noises are also reduced. (Paper received on 12 October 1983.)

AUTHOR: HE Yi [0149 5669]  
PAN Jiaomai [3382 2403 7796]

ORG: HE of Shanghai Lamp Factory; PAN of East China Normal University

TITLE: "Spectrophotometric Determination of Thorium in Tungsten-base Alloy with Chlorophosphonazo-m-SO<sub>3</sub>H(CPAmS)"

SOURCE: Changchun FENXI HUAXUE [ANALYTICAL CHEMISTRY] in Chinese Vol 12 No 11, 20 Nov 84 pp 1000-1002

TEXT OF ENGLISH ABSTRACT: In 1N H<sub>2</sub>SO<sub>4</sub> medium, thorium forms a blue complex with chlorophosphonazo-m-SO<sub>3</sub>H with a maximum absorption at 670 nm and molar absorptivity of  $7.0 \times 10^4 \text{ l mol}^{-1} \text{ cm}^{-1}$ . The composition ratio for Th/CPAmS is found to be 1:2 by the equilibrium shift method. Beer's law is obeyed for 0 to 40  $\mu\text{g ThO}_2$  in 25 ml solution. Most of the metal ions do not interfere with the determination of thorium. The method is simple and rapid. Results obtained are in good agreement with those obtained by gravimetry. (Paper received on 28 May 1983.)

AUTHOR: KE Wanqian [2688 1238 6197]

ORG: Central Laboratory, Geological Bureau, Jiangxi Province

TITLE: "Catalytic Polarographic Determination of Tungsten"

SOURCE: Changchun FENXI HUAXUE [ANALYTICAL CHEMISTRY] in Chinese Vol 12 No 11, 20 Nov 84 pp 1002-1004

TEXT OF ENGLISH ABSTRACT: A catalytic polarographic system, W(VI)-H<sub>2</sub>SO<sub>4</sub>-C<sub>6</sub>H<sub>5</sub>(OH)COOH-diphenylguanidine-NaClO<sub>3</sub>, for the determination of tungsten is proposed. Compared with the cinchonine system usually used in which the cinchonine wave interferes with tungsten at the 2 ppb/ml level, the diphenylguanidine system has no such interference and makes the catalytic current more stable and reproducible. The calibration curve for tungsten is linear within a range of 2 to 120 ppb/ml. There is no interference in the presence of 60 times of vanadium and 400 times of chromium. This method is simple and accurate, and has been applied to the analysis of geological standard samples. (Paper received on 10 June 1983.)

AUTHOR: ZOU Mingzhu [6760 2494 3796]  
YANG Haiquan [2799 3189 3123]  
HUANG Guoliang [7806 0948 5328]

ORG: Department of Chemistry, Jilin University

TITLE: "Application of Platinum Ball Electrode with Mercury-plated Film  
in Voltammetry"

SOURCE: Changchun FENXI HUAXUE [ANALYTICAL CHEMISTRY] in Chinese Vol 12 No 11,  
20 Nov 84 pp 1011-1013

TEXT OF ENGLISH ABSTRACT: A new method for preparing a Pt ball mercury film  
electrode is described. The mercury film on a Pt ball was plated using a  
technique of vaporization under a pressure reduced to 200 mm Hg. The electrode  
has been successfully used for anodic stripping voltammetry and polarography.  
(Paper received on 13 July 1983.)

AUTHOR: LIU Zhongchen [0491 1813 5256]  
XU Lu [6079 4389]  
MA Ying [7456 1758]  
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ORG: Changchun Institute of Applied Chemistry, Chinese Academy of Sciences

TITLE: "Computerized Emission Spectrographic Microphotometer. III. Interface for Semiautomated and Automated Systems"

SOURCE: Changchun FENXI HUAXUE [ANALYTICAL CHEMISTRY] in Chinese Vol 12 No 11, 20 Nov 84 pp 1022-1024

TEXT OF ENGLISH ABSTRACT: This is the third part of "Computerized Emission Spectrographic Microphotometer (Model MDI-II)." This portion describes the design principle, components and trial-producing of the interface of a microcomputer-based semiautomated and automated sampling system of this instrument. (Paper received on 29 August 1983.)

9717

CSO: 4009/1057

JPRS=CST-85-030  
4 September 85

AUTHOR: GU Guoying [7357 0948 5391]  
SHI Meijue [2457 5019 3778]  
DUO Fengqin [1122 7364 3830]

ORG: Institute of Atomic Energy

TITLE: "Multielement Determination of Major Constituents in Seawater Using Sequential ICP-AES and Studies on Related Interelements Effects"

SOURCE: Changchun FENXI HUAXUE [ANALYTICAL CHEMISTRY] in Chinese Vol 13, No 1, 20 Jan 85, pp 24-29

TEST OF ENGLISH ABSTRACT: A method of determination of major constituent, including nonmetals(B,S) and metals (Ca, Mg, Sr, Na) in seawater, using a sequential ICP spectrometer has been worked out. The samples should be diluted 10 times for stable nebulization and reduction of interelement effects. Two sets of working parameters-1.2 KW, 1/min carrier gas flow and 800 W, 1.4/min-have been compared. The interelement effects can be eliminated by the former set. The precision of 2-4%, and the deviation of 2-4% of the experimental results from calculated values are obtained for the salty standard of seawater. (Paper received on 13 Dec 83)

12949  
CSO: 4009/1052

AUTHOR: FENG Guoning [1409 0948 1337]  
YIN Zinan [3009 2737 2809]

ORG: Sixth Research Institute, Ministry of Nuclear Industry

TITLE: "Volumetric Determination of Uranium in Uranium Ores"

SOURCE: Changchun FENXI HUAXUE [ANALYTICAL CHEMISTRY] in Chinese Vol 13,  
No 1, 20 Jan 85, pp 37-40

TEXT OF ENGLISH ABSTRACT: Thirty eight typical uranium ores were analyzed for the determination of uranium by ferrous method, titanous method and microvolumetric method. A comparison of six kinds of dissolving methods and an assessment of the systematic error, accuracy and precision of methods have been made. (Paper received on 3 Aug 83)

12949  
CSO; 4009/1052

AUTHOR: HE Xiwen [0149 6932 2429]  
PAN Shenshi [3382 3234 1102]  
ZHANG Dongrui [1928 2639 3843]

ORG: Department of Chemistry, Nankai University

TITLE: "A New Mathematical-Differentiating Model for The Classification Between Mononuclear and Polynuclear Complexes in Extraction"

SOURCE: Changchun FENXI HUAXUE [ANALYTICAL CHEMISTRY] in Chinese Vol 13, No 1, 20 Jan 85, pp 1-5, 65

TEST OF ENGLISH ABSTRACT: A New mathematical-differentiating model is proposed for differentiation between mononuclear and polynuclear complexes in extraction system. It is shown theoretically and experimentally that mathematical differentiating equation may be used to classify extraction complexes of the form  $A_mB_n$ , where  $m/n = 1$ , into two different groups: one group comprises complexes of  $m = 1$ , and another group contains those of  $m > 1$ . The values of  $m$  of complexes ( $A_mB_n$ ) or  $m$  and  $n$  of complexes ( $A_mB_n$ ) can be obtained from spectrophotometric data through the equations.

The system thallium-(vanadium)-1-(2-pyridylazo)-2-naphthol, copper-2-(5-bromo-2-pyridylazo)-5-diethylaminophenol and lanthanum-alizarin complexes were used to demonstrate the applicability of the method. Good results were obtained for the four systems. (Paper received on 22 Jun 83)

12949

CSO: 4009/1052

AUTHOR: XU Yongyuan [1776 3057 3293]  
GAO Weixiang [7550 4850 4382]

ORG: Institute of Atomic Energy

TITLE: "Studies on Laser-Liquid Fluorimetry II. Determination of Rare Earth Elements Europium and Samarium"

SOURCE: Changchun FENXI HUAXUE [ANALYTICAL CHEMISTRY] in Chinese Vol 13, No 1, 20 Jan 85, pp 16-20

TEXT OF ENGLISH ABSTRACT: The ternary complexes of europium and samarium extracted into benzene emit strong fluorescences under irradiation of UV laser. The optimum conditions for determining simultaneously Eu and Sm on the UA-3 laser uranium analyzer have been studied, and the gated detection system of the analyzer have been modified. The detection limits are 0.04 ppt for Eu and 0.3 ppt for Sm. The method is simply and highly sensitive and can be used for the determination of Eu and Sm in single or mixed rare earth oxides, and in geological samples. (Paper received on 13 Dec 83)

12949

CSO: 4009/1052

AUTHOR: WANG Jisen [3769 4949 2773]  
HAN Peng [7281 7720]  
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ORG: Chengdu College of Geology

TITLE: "Determination of Gold and Palladium in Ores By Atomic Absorption Spectrophotometry Using TRI-n-Octylamine Loaded with Polyurethane Foam"

SOURCE: Changchun FENXI HUAXUE [ANALYTICAL CHEMISTRY] in Chinese Vol 13, No 2, 20 Feb 85 pp 101-104

TEXT OF ENGLISH ABSTRACT: A method is described in which both Au and Pd are selectively separated from aqueous solution using an adsorbing agent tri-o-octylamine loaded on polyurethane foam, followed by desorption with thiourea and atomic absorption spectrometric determination. The method has been used to determine Au and Pd at 0.1 g/t level in ores. The RSD is 2.46% for Pd and 4.86% for Au. (Paper received on 17 Jan 84)

12949

CSO: 4009/1053

Chemistry

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HE Chunfu [6320 2504 4395]  
LIN Jingxiang [2651 2529 4382]

ORG: Changchun Institute of Applied Chemistry, Academia Sinica

TITLE: "Determination of 15 Rare Earth Elements in Rare Earth Mixtures By X-Ray Fluorescence Using Filter Paper Technique"

SOURCE: Changchun FENXI HUAXUE [ANALYTICAL CHEMISTRY] in Chinese Vol 13, No 2, 20 Feb 85 pp 105-108

TEXT OF ENGLISH ABSTRACT: In this method the sample preparation is very simple, just to drop the sample solution onto a circular piece of filter paper, after drying it is ready for analysis. For a single analysis of all 15 rare earth elements, only 1 to 2 mg of the sample is needed and the time taken is 10 min. The analytical results are not affected by sample weight, provided the normalization composition method is applied. The method can be applied to the determination of RE in the intermediate product of the separation process employing solvent extraction or ion-exchange technique with satisfactory precision. (Paper received on 7 Feb 84)

12949  
CSO: 4009/1053

Chemistry

AUTHOR: WU Jiaqi [0702 1367 7871]  
NI Qidao [0242 0366 6670]  
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ORG: University of Science and Technology of China

TITLE: "A Study of Dual-Wavelength Spectrophotometry I. A Computerized Method For The Selection Of Pairs Of Wavelength"

SOURCE: Changchun FENXI HUAXUE [ANALYTICAL CHEMISTRY] in Chinese Vol 13, No 2, 20 Feb 85 pp 132-136

TEXT OF ENGLISH ABSTRACT: A computer program is compiled to select the optimum pairs of wavelength for the dual-wavelength spectrophotometric determination. Experiments with two-component systems Zn-Cd, P-As and Fe-Ti are carried out to verify the capability of the program. The results are satisfactory, and show that this method is suitable to various two-component systems. (Paper received on 15 Nov 83)

12949  
CSO: 4009/1053

Chemistry

AUTHOR: WANG Shuying [3769 3219 5391]  
BAI Litao [4101 4409 3447]  
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ORG: Changchun Institute of Applied Chemistry, Academia Sinica

TITLE: "Determination of Microamount Impurities Cu, Fe, Cd And Pb in High-Purity Zinc by Emission Spectrography"

SOURCE: Changchun FENXI HUAXUE [ANALYTICAL CHEMISTRY] in Chinese Vol 13, No 2, 20 Feb 85 pp 136-138

TEXT OF ENGLISH ABSTRACT: Metallic zinc samples are transformed into oxide and Bi is used as an internal standard. After the mixture is finely ground and mixed, it is filled in the graphite anode and excited with a DC arc and detected by a medium quartz spectrograph. The concentration ranges of determination are 0.000125-0.004% Cu, 0.00025-0.008% Pb and Cd, and 0.0006%-0.008% Fe. (Paper received on 5 Dec 83)

12949  
CSO: 4009/1053

Chemistry

AUTHOR: GAO Caisheng [7559 2088 3932]  
ZHANG Baochuan [1728 1405 1557]  
HU Shifu [0729 0013 1381]

ORG: Northwest Institute of Nuclear Technology

TITLE: "Rapid Determination of Major Components in Silicate Rocks-  
Decomposition By Fusion With Lithium Metaborate and Determination By  
Atomic Absorption Spectrophotometry"

SOURCE: Changchun FENXI HUAXUE [ANALYTICAL CHEMISTRY] in Chinese Vol 13,  
No 2, 20 Feb 85 pp 139-142

TEXT OF ENGLISH ABSTRACT: Rock samples are decomposed by fusion with  
lithium metaborate and the solutions obtained are used for determination  
of 9 major elements with AAS. The optimum digesting conditions of melt,  
depolymerization of the silicate acid polymer, and interelemental  
interferences in AAS have been studied. The absolute errors of analytical  
results are within the tolerance set by the Ministry of Geology. (Paper  
received on 5 Dec 83)

12949  
CSO: 4009/1053

Chemistry

AUTHOR: ZHANG Shuo [1728 4311]  
ZHANG Chunxu [1728 2504 3563]  
CHEN Jinsheng [7115 6651 3932]

ORG: Chemistry Department of Nankai University

TITLE: "Use Of Electronic Computer In Ion-Selective Electrodes (I)  
Determination Of Potassium And Sodium Ions As Interfered With Each Other"

SOURCE: Changchun FENXI HUAXUE [ANALYTICAL CHEMISTRY] in Chinese Vol 13,  
No 2, 20 Feb 85 pp 145-148

TEXT OF ENGLISH ABSTRACT: Aequation has been deduced for the simultaneous determination of two mutual-interfere elements, such as potassium and sodium, by using ion-selective electrodes and electronic computer. A running program has also been drafted. The program is relatively simple and the procedure is convenient to determine mutual-interference elements with satisfactory results. (Paper received on 18 Jan 84)

12949  
CSO: 4009/1053

Chemistry

AUTHOR: XUAN Weikang [1357 4850 1660]  
CHEN Huajing [7115 5478 7234]

ORG: XUAN of Shanghai Research Institute of Iron and Steel  
CHEN of Ma'anshan College of Iron and Steel Technology

TITLE: "Determination of Germanium By Hydride Generation-Atomic  
Absorption Spectrophotometry With Oxygen Shielded Air-Acetylene Flame"

SOURCE: Changchun FENXI HUAXUE [ANALYTICAL CHEMISTRY] in Chinese Vol 13,  
No 2, 20 Feb 85 pp 142-145

TEXT OF ENGLISH ABSTRACT: Five modes of atomization for Ge determination have been studied. Oxygen shielded air-acetylene flame mode is selected because of its simplicity in use and 5-fold increase in sensitivity. Addition of sodium phosphate increases the sensitivity for Ge further by 7-fold. The characteristic concentration is 0.035  $\mu\text{g/ml}$ , RSD is 3.2%. When Ar-H<sub>2</sub> or N<sub>2</sub>O-C<sub>2</sub>H<sub>2</sub> flame is used with sodium phosphate, the sensitivity for Ge is 3-10 fold greater than that without adding sodium phosphate in the literature. (Paper received on 7 Dec 83)

12949  
CSO; 4009/1053

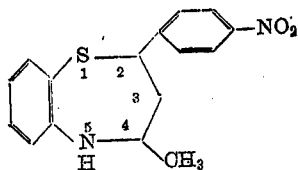
AUTHOR: PAN Zuohua [3382 0146 5478]  
JIN Xianglin [6855 4382 2651]  
TANG Youqi [0781 2589 4388]  
et al.

ORG: Department of Chemistry, Beijing University

TITLE: "Crystal Structural Research on 2-Aryl-4-Methyl-2,3,4,5-Tetrahydro-(1,5)-Benzothiazepines"

SOURCE: Shanghai HUAXUE XUEBAO [ACTA CHIMICA SINICA] in Chinese Vol 43 No 3, Mar 85 pp 207-211

TEXT OF ENGLISH ABSTRACT: The crystal structures for cis- and trans-isomers of 2-(p-nitrophenyl)-4-methyl-2,3,4,5-tetrahydro-(1,5)-benzothiazepines were determined by the direct method and refined by the block least squares routine. The final R factors are:  $R=0.0661$ ,  $R_w=0.0661$  for the cis-isomer and  $R=0.0705$ ,  $R_w=0.0571$  for the trans-isomer. The crystal form of the cis-isomer is orthorhombic, with space group  $D_{2h}^{10}$ - $Pbnc$ ,  $Z=8$ , and crystallographic parameters  $a=8.326(1)\text{\AA}$ ,  $b=14.865(5)\text{\AA}$ ,  $c=24.533(4)\text{\AA}$ ,  $d_c=1.31\text{g/cm}^3$ ,  $F(000)=1264e$ ,  $\mu(\text{MoK}\alpha)=2.2\text{ cm}^{-1}$ . The crystal of trans-isomer is of monoclinic form, with space group  $C_{2h}^6$ - $C2/c$ ,  $Z=8$ , and crystallographic parameters  $a=22.366(3)\text{\AA}$ ,  $b=12.488(2)\text{\AA}$ ,  $c=12.483(2)\text{\AA}$ ,  $\beta=121.01^\circ(1)$ ,  $d_c=1.34\text{g/cm}^3$ ,  $F(000)=1264e$ ,  $\mu(\text{MoK}\alpha)=2.2\text{ cm}^{-1}$ . The result of crystal structure analysis shows that the cis-isomer is of the quasi-chair conformation whereas the trans-isomer is of the quasi-twisted boat conformation. (Paper received on 7 June 1983, edited copy received on 4 August 1984.)



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LIANG Xiaotian [2733 2556 1131]

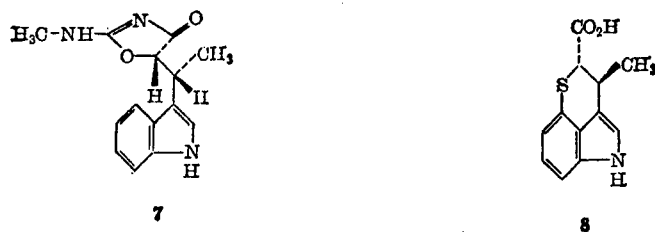
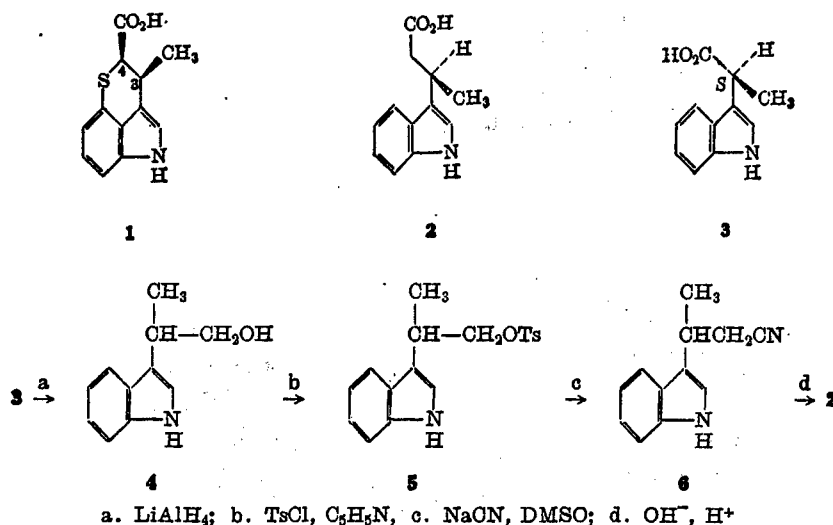
ORG: Institute of Materia Medica, Chinese Academy of Medical Sciences,  
Beijing

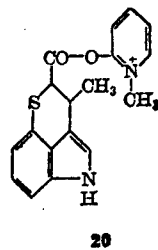
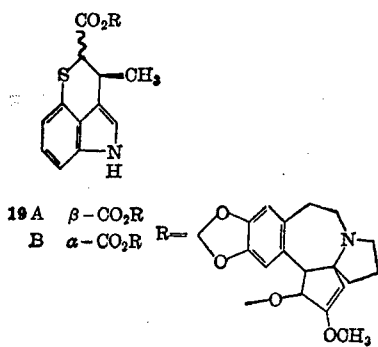
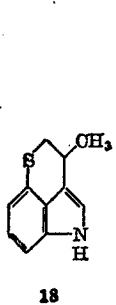
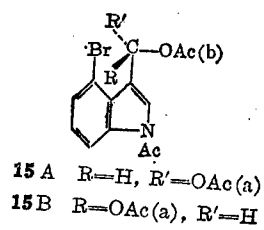
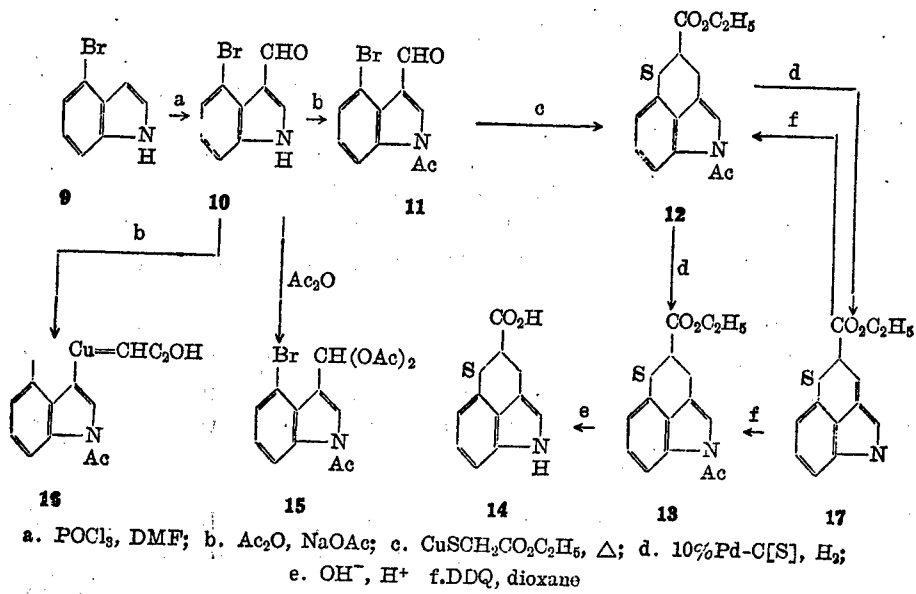
TITLE: "The Stereochemistry of Chuangxinmycin"

SOURCE: Shanghai HUAXUE XUEBAO [ACTA CHIMICA SINICA] in Chinese Vol 43 No 3,  
Mar 85 pp 250-256

TEXT OF ENGLISH ABSTRACT: Chuangxinmycin was shown by chemical correlation to have a 3S, 4R configuration as shown by 1. It is surprising that 1 has the opposite absolute configuration from indolmycin (7) with the same carbon skeleton.

The carboxyl group of norchuangxinmycin (14) and the methyl group of decarboxychuangxinmycin (18) were found to have preferred equatorial conformations with no observable anomeric effect in the former. Thus the bulkier carboxyl group of 1 itself must adopt the equatorial position predominantly, if not exclusively, in solution, a situation already found prevailing in the crystalline state by X-ray diffraction. (Paper received on 13 February 1984.)





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TITLE: "The Crystal Structure of Cesium Iodate"

SOURCE: Shanghai HUAXUE XUEBAO [ACTA CHIMICA SINICA] in Chinese Vol 43 No 3, Mar 85 pp 271-274

TEXT OF ENGLISH ABSTRACT: The crystal structure of cesium iodate has been determined by powder X-ray diffraction techniques and its optical characters have been studied. It belongs to the monoclinic system with lattice parameters at 20°C:  $a=6.613\text{\AA}$ ,  $b=6.613\text{\AA}$ ,  $c=4.676\text{\AA}$ ,  $\beta=90^{\circ}8' \pm 8'$ .

Its space group is Pm. There are two formula weights in a unit cell. The two iodine atoms are situated at the 1(a) and 1(b) equivalent positions, the two Cs atoms are situated at the 1(a) and 1(b) equivalent positions, the six oxygen atoms are situated at the 2(c), 2(c), 1(a) and 1(b) positions. The thermal expansion coefficients of  $\text{CsIO}_3$  have been determined by high temperature X-ray powder diffraction. They are:  $\beta_a = \beta_b = \beta_c = 44.2 \times 10^{-6}/\text{degree}$ . The expansion coefficients keep constant between room temperature and 400°C, indicating that there is no displacive phase transition within this temperature range. The change of the structural type in the alkalia iodates is discussed. (Paper received on 15 December 1983.)

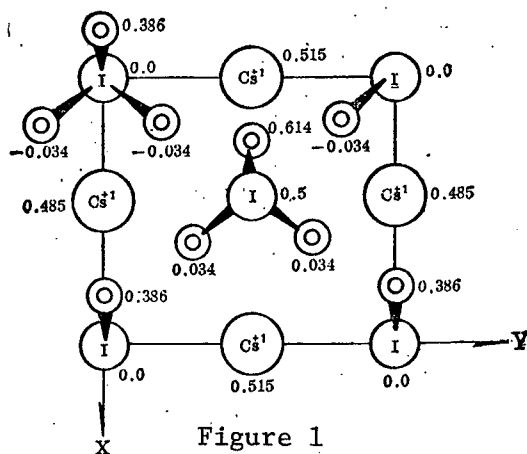


Figure 1  
Projection of  $\text{CsIO}_3$  Crystal Structure  
Along Z Direction

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WEN Shulin [3306 2885 2651]

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TITLE: "Lean Lanthanum Zirconate Titanate Structure Images and Defects"

SOURCE: Shanghai HUAXUE XUEBAO [ACTA CHIMICA SINICA] in Chinese Vol 43 No 3,  
Mar 85 pp 282-285

TEXT OF ENGLISH ABSTRACT: The microstructures of lead lanthanum zirconate titanate (PLZT) ceramics which have mole ratios of 8/65/35 and 7.9/70/30 were observed by high resolution electron microscope at lattice level. For the first time, the structure images of the PLZT ceramics were obtained. The results indicate that the samples with mole ratio 7.9/70/30 have more defects than those with mole ratio 8/65/35, so the samples with ratio 8/65/35 are much more stable. (Paper received on 31 January 1984.)

9717  
CSO: 4009/1054

AUTHOR: PAN Jiangqing [3382 3068 1987]  
ZHANG Can [1728 3503]  
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TITLE: "Study Of The Photoprotecting Behaviour Of Copolymer Of Styrene-2, 2, 6, 6-Tetramethyl-4-Piperidinyl Methacrylate"

SOURCE: Beijing GAOFENZI TONGXUN [POLYMER COMMUNICATIONS] in Chinese No 3, Jun 85, pp 173-177

TEXT OF ENGLISH ABSTRACT: The behaviour of photoprotecting of copolymer of styrene-2, 2, 6, 6-tetramethyl-4-piperidinyl methacrylate(PDS) and bis-(2,2,6,6-tetramethyl-4-piperidinyl) sebacate(Tinuvin-770) for polypropylene have been studied by determination of mechanical properties, molecular weight, ESR and IR of polypropylene. The results showed that there are some analogies and some differences from each other in their behaviour of photoprotection, i.e. either PDS or Tinuvin-770 are stabilized by mechanism of stable free radical ( $>N-O^{\bullet}$ ) and also can graft on polypropylene. Their differences of photoprotection are attributed to forming macromolecule of PDS to improve its heat resistance, extration resistance and compatibility of PDS with polypropylene. Furthermore, there are about 20 piperidine functional groups on each PDS molecular chain, that has a slightly-crosslinking effect. As a result nonvolatile carbonyls are accumulated faster than in the polypropylene containing Tinuvin-770, and strength retention is better and molecular weight decreasing is slower than that of polypropylene containing Tinuvin-770. The measurement of photo-oxidation process of polypropylene showed that the variation of concentration of stable free radical ( $>-ON^{\bullet}$ ) with the increasing of photo-oxidation time is relatively small, especially in later period while there is a sharp peak value in the curve for Tinuvin-770 at earlier period. PDS is much more resistant to photolysis so that PDS possesses high photoprotecting effectiveness. (Paper received on 5 Mar 83)

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12949

CSO: 4009/1085

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TITLE: "Morphology Of EPR-g-PS Thermoplastic Elastomer"

SOURCE: Beijing GAOFENZI TONGXUN [POLYMER COMMUNICATIONS] in Chinese  
No 3, Jun 85 pp 197-201

TEXT OF ENGLISH ABSTRACT:

Morphology of graft copolymer EPR-g-PS, EP copolymer (EPR) with polystyrene (PS) grafts, prepared through macromer copolymerization, has been studied by transmission electron microscopy (TEM). Results show that the copolymer consists of two-phases with PS microdomains several hundred Å in size dispersed in EPR rubber matrix. The microdomains change in shape from spheric to rod-like as PS-content in the copolymers increases. Small amount of EPR-g-PS in EPS+PS blends acts as an "emulsifier", making the microdomains in the blends smaller and the dispersion more homogeneous. Multi-transition behavior of the copolymers confirms the existence of separated phases. (Paper received on 20 Apr 83)

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12949

CSO: 4009/1085

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CHEN Yujun [7115 3768 0689]

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TITLE: "Study Of Crystallinity Of Poly(Ethylene Terephthalate)"

SOURCE: Beijing GAOFENZI TONGXUN [POLYMER COMMUNICATIONS] in Chinese  
No 3, Jun 85 pp 207-211

TEXT OF ENGLISH ABSTRACT:

Double peaks of cold crystallization from DSC thermograms of PET is found to be connected with the time of storing and the humidity of the storing place. Data from Fourier transform infrared spectroscopy, kinetics of absorbed water and X-ray diffraction indicated that water may take part in plasticization and induced crystallization to the amorphous PET. (Paper received on 26 Sep 83)

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CSO: 4009/1085

Chemistry

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PAN Enli [3382 1867 7812]  
ZHOU Changyu [6760 2490 3768]

ORG: Changchun Institute of Applied Chemistry, Academia Sinica, Changchun

TITLE: "Kinetic Study On The Polymerization Of Butadiene With  $\text{LnCl}_3\text{-C}_2\text{H}_5\text{OH-AiR}$ , Catalysts"

SOURCE: Beijing GAOFENZI TONGXUN [POLYMER COMMUNICATIONS] in Chinese  
No 3, Jun 85 pp 167-172

TAXT OF ENGLISH ABSTRACT: The number of active centers and reaction rate constants in the polymerization system of  $\text{NdCl}_3\text{-C}_2\text{H}_5\text{OH-AiR}$  -butadiene have been determined by means of tritiated alcohol quenching and kinetic methods. The experimental results show that the number of active centers in this polymerization system lies in the range of  $0.5\text{-}2.8 \times 10^{-2}$  mol/mol Nd with respect to two kinds of aluminium alkyls used. In the investigated range the propagation rate constant does not depend on the nature of AiR and polymerization conditions except polymerization temperature, while the rate constant of chain transfer is affected markedly by variations of polymerization conditions.

12949  
CSO: 4009/1085

Chemistry

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HU Jingyu [2083 2533 0151]

ORG: Changchun Institute of Applied Chemistry, Academia Sinica, Changchun

TITLE: "Kinetic Study On The Polymerization Of Butadiene With  $\text{LnCl}_3$ -  
 $\text{C}_2\text{H}_5\text{OH}-\text{AlR}_3$  Catalysts"

SOURCE: Beijing GAOFENZI TONGXUN [POLYMER COMMUNICATIONS] in Chinese  
No 3, Jun 85 pp 161-167

TEXT OF ENGLISH ABSTRACT: The rate constants of chain transfer in the polymerization of butadiene with  $\text{LnCl}_3-\text{C}_2\text{H}_5\text{OH}-\text{AlR}_3$  catalysts ( $\text{Ln}=\text{La}$ ,  $\text{Nd}$ ,  $\text{Sm}$ ,  $\text{Gd}$ ,  $\text{Dy}$ ,  $\text{Ho}$  or  $\text{Y}$ ;  $\text{AlR}_3 = \text{Al}(\text{C}_2\text{H}_5)_3$  or  $\text{Al}(\text{i-C}_4\text{H}_9)_3$ ) were evaluated. Analogous to the propagation rate constants described in the early paper these rate constants varies also with the rare earth element used in the catalysts and decreases in the same order. The kinetic study showed that the deactivation of active center initiated with  $\text{Sm}$ -catalyst was second order. Besides, the mechanism of deactivation of active center has been proposed for the present polymerization system.

12949  
CSO: 4009/1085

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CHEN Jianxin [7115 1696 2450]  
REN Chigang [0117 3589 0474]

ORG: None

TITLE: "A Scanning Proton Probe Using External Beam"

SOURCE: Shanghai FUDAN XUEBAO (ZIRAN KEXUE BAN) [FUDAN JOURNAL (NATURAL SCIENCE)] in Chinese Vol 23, No 4, Dec 84 pp 385-396

TEXT OF ENGLISH ABSTRACT:

The recent progress of the proton probe using external beam at Fudan University is described. A PDP-11/34 computer is used for on-line experiment control, data acquisition and off-line analysis. All spectra from the scanned target area are stored and analysed to obtain the various distributions of the elements ( $z > 13$ ) in the sample surface layer. The external proton beam is produced by means of a pin-hole sealed up with an  $8\mu\text{m}$  vacuumtight Kapton exit foil. The measured beam spot on the target is  $26\mu\text{m}$  in diameter with a beam current of 20 pA. A fragment of an ancient Chinese copper mirror made in Tang dynasty (618~907) was scanned in lateral direction. The PIXE spectra of the copper mirror were analysed using a FORTRAN program AXIL. It is interesting that the measured concentration ratios of Sn/Cu, Pb/Cu, Fe/Cu, Zn/Cu, Mn/Cu, Ca/Cu, Ni/Cu and Cr/Cu near the surfaces of both sides back and front of the mirror are much greater than that inside it as expected. This experimental result has a good agreement with the so called extra-ordinary segregation effect in metallurgy. (Paper received on 8 Dec 83)

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12949

CSO: 4009/1092

## Computer Development and Application

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ORG: None

TITLE: "Backward Implication Algorithm for Test Generation of Combinational Circuits"

SOURCE: Shanghai FUDAN XUEBAO (ZIRAN KEXUE BAN) [FUDAN JOURNAL (NATURAL SCIENCE)] in Chinese Vol 23, No 4, Dec 84 pp 375-384

### TEXT OF ENGLISH ABSTRACT:

On the basis of six-valued logic systems, six-valued sensitive cubes and primary cubes are presented in the algorithm—Backward Implication Algorithm. The intersection operation on  $H$  set is defined. The algorithm adopts the advantages of Critical Path Method,  $D$ -Algorithm and 9-V Algorithm, overcomes some shortcomings of them. It is a new effective test generation algorithm for combinational circuits.

A program based on this algorithm has been developed on PDP-11/23, which is written in FORTRAN IV. (Paper received on 10 Sep 83)

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CSO: 4009/1092

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TITLE: "Superconducting Critical Temperature of Amorphous Zr-Si Alloys"

SOURCE: Beijing DIWEN WULI [ACTA PHYSICA TEMPERATURAE HUMILIS SINICA] in Chinese Vol 7, No 1, Mar 85 pp 19-30

TEXT OF ENGLISH ABSTRACT:

Zr-metalloid-type amorphous alloys  $Zr_{100-x}Si_x$  ( $8.8 \leq x \leq 15.3$ ), were prepared by a melt-spinning technique. The dependence of the superconducting critical temperature,  $T_c$ , on the alloy composition shows that  $T_c$  decreases linearly with increasing Si content at a rate of 0.18 K/at.%. The extrapolated  $T_c$  of the pure amorphous Zr amounts to 5.15 K. This value is in good agreement with the result deduced by Onn et al., based on low-temperature specific-heat measurements of amorphous Zr-Fe alloys.

Isothermal anneals of  $Zr_{87.7}Si_{12.3}$  were conducted at 310, 370, 415 and 445°C. The  $T_c$  measurements of these samples show that the structural relaxation behavior is much different from that of the Zr-TM-type amorphous alloys Zr-Co and Zr-Ni.  $T_c$  of  $Zr_{87.7}Si_{12.3}$  changes with annealing time at a larger rate, tends to saturate after several hours and does not obey the  $\ln t$  rule. Crystallization leads to a drastic decrease of  $T_c$ . These results, combined with DCS measurements, are used for a discussion of the structural relaxation and crystallization.

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12949

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TITLE: "Superconductivity of Ternary Amorphous Alloy  $Zr_{76}Cu_{14}Ni_{10}$  Under High Pressure and Low Temperature"

SOURCE: Beijing DIWEN WULI [ACTA PHYSICA TEMPERATURAE HUMILIS SINICA] in Chinese Vol 7, No 1, Mar 85 pp 37-40

TEXT OF ENGLISH ABSTRACT:

Ternary amorphous alloy  $Zr_{76}Cu_{14}Ni_{10}$  have been prepared by melt spinning. The relationship between the resistance of the alloy and temperature was studied under different pressures and after removing the 10 kbar pressure. The results show that at 1 bar, 7.3 kbar and 10 kbar,  $T_c$  values are 3.32, 3.39 and 3.42 K respectively.  $T_c$  increases with increasing pressure but  $\Delta T_c$  remains constant 0.05 K. The residual resistance of the alloy decreases gradually with increasing pressure. The 10 kbar pressure was removed after 168 hours. The results indicate that  $T_c$  is reversible but the residual resistance is irreversible.

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CSO: 4009/1091

## Cryogenics

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TITLE: "Critical Current of Nb<sub>3</sub>Sn Superconducting Tapes in High Magnetic Fields"

SOURCE: Beijing DIWEN WULI [ACTA PHYSICA TEMPERATURAE HUMILIS SINICA] in Chinese Vol 7, No 1, Mar 85 pp 46-48

### TEXT OF ENGLISH ABSTRACT:

The measurements of critical current of a CVD-Nb<sub>3</sub>Sn tape and a modified diffusion processed Nb<sub>3</sub>Sn tape at 4.2 K in high magnetic fields ( $\sim 22$ T) show that these two Nb<sub>3</sub>Sn tapes have good superconducting properties. The critical current density  $J_c$  (Nb<sub>3</sub>Sn) at 4.2 K is as follows:

For diffusion processed Nb<sub>3</sub>Sn tape,  $3.0 \times 10^5$  A/cm<sup>2</sup> (12T) and  $1.4 \times 10^5$  A/cm<sup>2</sup> (15T);

For CVD-Nb<sub>3</sub>Sn tape,  $2.9 \times 10^5$  A/cm<sup>2</sup> (12T) and  $6.0 \times 10^4$  A/cm<sup>2</sup> (15T), respectively.

A discussion of the measurements has also been made.

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CSO: 4009/1091

## Cryogenics

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TITLE: "Magnetic Behavior of Amorphous  $(\text{Fe}_{1-x}\text{Cr}_x)_84\text{B}_{16}$  Alloys Above The Critical Concentration"

SOURCE: Beijing DIWEN WULI [ACTA PHYSICA TEMPERATURAE HUMILIS SINICA] in Chinese Vol 7, No 1, Mar 85 pp 41-45

### TEXT OF ENGLISH ABSTRACT:

The ribbons of amorphous  $(\text{Fe}_{1-x}\text{Cr}_x)_84\text{B}_{16}$  ( $0 \leq x \leq 0.46$ ) alloys were produced by melt quenching using a rotating drum apparatus. The AC susceptibility of low magnetic field in relation with temperature was measured by using an alternating current mutual inductance bridge. The magnetic phase diagram of amorphous FeCrB alloys has been obtained. Measurements of the electrical resistivity anomaly in that concentration range were made by means of a fourprobe technique. The coexistence of the quasi-spinning glass, the resistivity anomaly and invar effect of amorphous FeCrB alloys has been discussed on the basis of the existence of the free Fe and Cr atoms and spin clusters which is of antiferromagnetic coupling.

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CSO: 4009/1091

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TITLE: "An Experimental Gas Helium Cooling Device for Superconducting Magnets"

SOURCE: Beijing DIWEN WULI [ACTA PHYSICA TEMPERATURAE HUMILIS SINICA] in Chinese Vol 7, No 1, Mar 85 pp 67-71

TEXT OF ENGLISH ABSTRACT: A gas helium cooling experimental device with its temperature measuring system using a microcomputer have been developed. A small Nb<sub>3</sub>Sn magnet indirectly cooled with this device has been tested. The experimental results of the system from 4.5K to 16K are also presented.

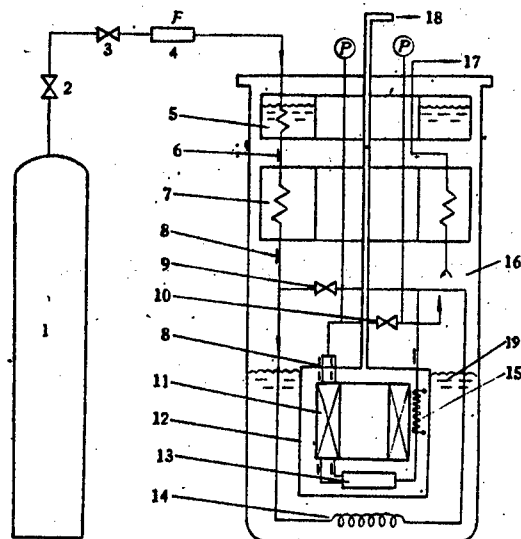


Figure 1 The experimental cooling device

- |   |                                     |
|---|-------------------------------------|
| 1. High pressure He tank                    | 2. Pressure relief valve            |
| 3. Discharge valve                          | 4. Flowmeter                        |
| 5. GHe-LN heat exchanger                    | 6. Pt resistance thermometer        |
| 7. GHe-GHe heat exchanger                   | 8. AuFe-NiCr thermocouple           |
| 9. Bypass valve                             | 10. Cryogenic pressure relief valve |
| 11. Nb <sub>3</sub> Sn magnet               | 12. Vacuum chamber                  |
| 13. Mixing chamber                          | 14. GHe-LHe heat exchanger          |
| 15. Heating wire for temperature regulating | 16. Dewar                           |
|   | 17. Return-air duct                 |
|   | 18. Exhaust                         |
|   | 19. Liquid He                       |

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CSO: 4009/1091

## Cryogenics

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TITLE: "The Magnetic Moment of the Superconducting Cylinder Closing Upon the Critical Temperature ( $T - T_c \ll T_c$ )

SOURCE: Beijing DIWEN WULI [ACTA PHYSICA TEMPERATURAE HUMILIS SINICA] in Chinese Vol 7, No 1, Mar 85 pp 49-53

### TEXT OF ENGLISH ABSTRACT:

The formula for the magnetic moment of a cylinder in the surface superconducting state, with the fluctuations of the order parameter being taken into account, is obtained in a parallel weak field [ $H \ll H_c(0)$ ] and closing upon the critical temperature ( $T - T_c \ll T_c$ ).

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CSO: 4009/1091

## Cryogenics

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TITLE: "The Critical Thickness of Josephson Junction"

SOURCE: Beijing DIWEN WULI [ACTA PHYSICA TEMPERATURAE HUMILIS SINICA] in  
Chinese Vol 7, No 1, Mar 85 pp 12-18

### TEXT OF ENGLISH ABSTRACT:

Experimental investigation has been made on some Pb-I-Pb tunnel junctions, whose insulation films have a particular thickness. The junction shows a typical  $I$ - $V$  character of a single-electron tunnel when  $T > 2.90$  K, and changes to show the typical  $I$ - $V$  curve of Josephson tunnel when  $t < 2.78$  K.

According to theoretical calculation, there is a critical thickness  $d_c$  for Josephson junction, which decreases when the temperature increases. This agrees with the experimental results.

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CSO: 4009/1091

Cryogenics

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TITLE: "Measurement of Magnetic Fields in Low Temperature with Hall Elements  
of GaAs"

SOURCE: Beijing DIWEN WULI [ACTA PHYSICA TEMPERATURAE HUMILIS SINICA] in  
Chinese Vol 7, No 1, Mar 85 pp 81-84

TEXT OF ENGLISH ABSTRACT:

Experimental results of Hall elements of GaAs under 4.2 K show that they have greater sensitivity in superconducting magnetic fields, better repetition and smaller linear error than those of others. It may be used for the measurement of high magnetic fields and be used as a probe for Gauss meter in low Temperature.

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CSO: 4009/1091

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TITLE: "An Automatic Trimming Algorithm of Integrated D/A Converters"

SOURCE: Shanghai FUDAN XUEBAO (ZIRAN KEXUE BAN) [FUDAN JOURNAL (NATURAL SCIENCE)] in Chinese Vol 23, No 4, Dec 84 pp 361-368

TEXT OF ENGLISH ABSTRACT:

At the beginning a mathematical model for automatic trimming of  $D/A$  converters is established, then the trimming algorithms of different  $D/A$  circuits are discussed. The results of computer simulation are also given. (Paper received on 10 Sep 83)

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CSO: 4009/1092

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TITLE: "Investigation of Problems About the Light Power Output of GaAs/GaAlAs DH Surface Emitting Diodes"

SOURCE: Beijing DIANZI KEXUE XUEKAN [JOURNAL OF ELECTRONICS] in Chinese Vol 7, No 3, May 85 pp 220-226

TEXT OF ENGLISH ABSTRACT:

A modified conventional RF sputtering equipment was used in preparing the  $\text{Al}_2\text{O}_3$  antireflective coating (ARC). An increase in the light power output of 30—66% at a driving current 200 mA for the GaAs/GaAlAs DH LEDs coated on light emitting surface with ARC thickness of about  $\lambda/4$  has been obtained. In the same case a light output increase of less than 30% for these degraded LEDs has been determined. It may probably be attributed to the defects formed in the bulk of the  $\text{Ga}_{1-x}\text{Al}_x\text{As}$  crystals caused by degradation of diodes restrict the increase of light output. (Paper received on 16 Aug 83 and finalized on 17 Sep 84)

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CSO: 4009/1055

## Electronics

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TITLE: "Computer-Aided Design of Parametric Amplifiers with Read-Type Varactors"

SOURCE: Beijing DIANZI KEXUE XUEKAN [JOURNAL OF ELECTRONICS] in Chinese Vol 7, No 3, May 85 pp 213-219

TEXT OF ENGLISH ABSTRACT: In this paper, a computer program is made for studying actual parametric amplifiers with hi-lo doping varactors. The main parameters of the parametric amplifier, e.g. working frequency, bias voltage, pumping power and negative resistance are obtained with this program. Then a basis for the design of parametric amplifiers is provided. (Paper received on 25 Aug 83 and finalized on 16 Nov 83)

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CSO: 4009/1055

Electronics

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TITLE: "The Optimal Design Principle of the Current Switching Multiplier"

SOURCE: Beijing DIANZI KEXUE XUEKAN [JOURNAL OF ELECTRONICS] in Chinese Vol 7,  
No 3, May 85 pp 203-212

TEXT OF ENGLISH ABSTRACT:

In this article, the operation of the current switching multiplier is quantitatively analyzed in some detail. The relations between the optimum operation-state and the parameters of circuit elements in the multiplier are given.

Furthermore the principle of optimum design is derived and proved experimentally.

In addition, the stability of the differential inductor and the parasitic harmonic effect on the frequency stability of multiplier output signal is also discussed.

(Paper received on 1 Aug 83 and finalized on 5 Mar 84)

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CSO: 4009/1055

## Electronics

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TITLE: "On the Synchronizing Band of the RHIL"

SOURCE: Beijing DIANZI KEXUE XUEKAN [JOURNAL OF ELECTRONICS] in Chinese Vol 7,  
No 3, May 85 pp 188-194

### TEXT OF ENGLISH ABSTRACT:

Rational harmonic injection locking (RHIL) can make the whole circuit simpler and more flexible than harmonic injection locking (HIL) does. A common formula of the synchronizing band  $\Delta\omega_{(m)}^{\pm}$  of the RHIL is derived and analysed in this paper. It shows that the formula of the synchronizing band of HIL given by I. Schmideg (1971) is a special case.

A method which is used to expand the RHIL's synchronizing band with full-pass network, is presented. With this method, a 2/3 injection-locking VHF divider made of IC FZIC is developed. Its stability factor  $n = \Delta f_{(\frac{1}{2})_{max}} / \Delta f_{[-40 \sim +85^{\circ}C]} \geq 4$ . For the original circuit,  $n \approx 0.6$ . It makes the RHIL of better practical value.  
(Paper received on 30 Aug and finalized on 25 Jan 84)

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CSO: 4009/1055

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TITLE: "Computation of Dyadic Green's Function for Generalized Cylinders in Free Space"

SOURCE: Beijing DIANZI KEXUE XUEKAN [JOURNAL OF ELECTRONICS] in Chinese Vol 7, No 3, May 85 pp 171-179

TEXT OF ENGLISH ABSTRACT: Dyadic Green's function is useful for solving the boundary problems in electromagnetic theory. The key problem involved is how to deal with the additional terms in the electric dyadic Green's function in the source region. In this paper, dyadic Green's functions for generalized cylinders in free space are derived with the technique given by the author (1984). The dyadic Green's functions for perfectly conducting wedges, half-planes and elliptic cylinders, whose integrals of continuous spectral  $h$  have been eliminated, are given particularly. (Paper received on 22 Sep 83 and finalized on 19 Nov 84)

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CSO: 4009/1055

## Electronics

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TITLE: "Calculation of Reflection Coefficient for Step-Open Waveguide with the Boundary Element Method"

SOURCE: Beijing DIANZI KEXUE XUEKAN [JOURNAL OF ELECTRONICS] in Chinese Vol 7, No 3, May 85 pp 161-170

### TEXT OF ENGLISH ABSTRACT:

In this paper, the boundary element method (BEM) and the finite element method (FEM) are compared. Then the formulation of Helmholtz equation by BEM and the calculation of the reflection coefficient for step-open parallel plate waveguide by BEM are presented. Finally the flow-chart of the program and the computed results are given. Comparison of the computed results for the standing wave state with those given by the related literature shows that the computed results are reasonable. (Paper received on 10 Oct 83 and finalized on 23 Nov 84)

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CSO: 4009/1055

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TITLE: "A Computer Method for Seeking the Ultimate Load of Structural Frames"

SOURCE: Tianjin TIANJIN DAXUE XUEBAO [JOURNAL OF TIANJIN UNIVERSITY] in Chinese No 2, Jun 84 pp 15-24

TEXT OF ENGLISH ABSTRACT: The principle of Neal and Symonds on finding the possible mode of collapse mechanism is discussed. A computer program RFMC is suggested which enables a lot of possible combined mechanisms to get the real collapse mechanism of a framed structure and the value of the ultimate load can be found. This method not only can permit the principle of Neal and Symonds to find a way of application but also avoid the tedious process of numerical calculations.

This paper gives a numerical calculated example to illustrate how to use the suggested method and at the same time gives the procedure by using computer program RFMC to obtain the ultimate load by combining automatically the possible collapse mechanisms.

Through an example of finding the ultimate load acting on a two-story framed structure, it can also be concluded that this method is applicable to multi-story frames as well. (Paper received on 15 Nov 83)

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CSO: 4009/1086

## Engineering

AUTHOR: YU Yixin [0151 6318 9515]

ORG: Power and Automation Engineering Department

TITLE: "A Reliability Calculation for a Long Distance Transmission Power System with Stability and Load Uncertainty"

SOURCE: Tianjin TIANJIN DAXUE XUEBAO [JOURNAL OF TIANJIN UNIVERSITY] in Chinese No 2, Jun 84 pp 25-39

TEXT OF ENGLISH ABSTRACT: This paper presents a reliability calculation for a long distance transmission power system by a continuous-time Markov Chains with periodic transition rates.<sup>1</sup> It is characterized by considering power system stability and load uncertainty. First we introduce briefly the model used, and then present the methods and procedures. A lot of research work has been done on the CDC-6400 computer using a Fortran program. It was shown that this method can give quite a lot of information and may be a viable approach. More research is still needed to simplify the calculation for a multimachine power system. (Paper received on 9 Dec 83)

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12949

CSO: 4009/1086

## Engineering

AUTHOR: LIAN Huaying [6647 5478 5391]  
HOU Zengyan [0230 2582 3508]

ORG: Chemical Engineering Department

TITLE: "An Investigation on the Natural Frequency of Vibration of Heat Exchanger Tubes"

SOURCE: Tianjin TIANJIN DAXUE XUEBAO [JOURNAL OF TIANJIN UNIVERSITY] in Chinese No 2, Jun 84 pp 81-89

### TEXT OF ENGLISH ABSTRACT:

The vibration of heat exchanger tubes due to cross—flowing fluids can lead to serious damage. In order to solve this we must determine the natural frequency of tubes when we design tubular heat exchangers.

This paper proposes a new method of calculating the natural frequency of tubes. It assumes exchanger tubes as continuous beams with points of support at the baffles, and the ends to be fixed in the tubesheet. The new calculating method may be used when the spans (the length of span between baffles or tube supports) are numerous and unequal, and it has the advantages of high accuracy, and wider application than that of formulas, and convenience for hand calculating and computation by electronic computers. (Paper received on 27 May 83)

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CSO: 4009/1086

AUTHOR: JIN Maochang [6855 2021 2490]

ORG: Chengdu Institute of Radio Engineering

TITLE: "The Underlying Principles and Application of Leak Detection Using Ionization Gauges Under Viscous Flow"\*

SOURCE: Beijing ZHENKONG KEXUE YU JISHU [VACUUM SCIENCE AND TECHNOLOGY] in Chinese Vol 4 No 4, Jul 84 pp 227-234

TEXT OF ENGLISH ABSTRACT: A brief review of the methods of leak detection of a large volume vacuum system and the probability of leak detection using high pressure ionization gauges are given. A physical model of flow of probe gases through tubes of vacuum systems for viscous flow is derived. According to this model, a viscous flow delay time  $\tau$ , a factor influencing delay time and the time for attaining a stable state are deduced. This analysis has been confirmed by experimentation. The dependence of the sensitivity and time response of leak detection on the relative position of gauges and leaks in the vacuum systems under viscous flow conditions is discussed at the end of the paper, and the selection of the probe gases is mentioned.

\*Received on 25 November 1982.

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AUTHOR: XIAO Shuyi [5135 2885 5030]  
ZHANG Ruifeng [1728 3843 1496]

ORG: Changchun Institute of Applied Chemistry, Chinese Academy of Sciences

TITLE: "Investigation of Fabrication and Characteristics of Indium-Tin Oxide (ITO) Films"\*

SOURCE: Beijing ZHENKONG KEXUE YU JISHU [VACUUM SCIENCE AND TECHNOLOGY] in Chinese Vol 4 No 4, Jul 84 pp 235-243

TEXT OF ENGLISH ABSTRACT: In this paper, it is reported that indium-tin oxide (ITO) thin films were prepared by an electron beam technique. The effect of heat treatment (300°C) in various environments on the electrical and optical properties of ITO prepared films has been investigated. The resistivity is decreased and optical transparency is particularly increased by heat treatment in H<sub>2</sub> or Ar. A sheet resistance between 4.5-20Ω/ and transmittance of over 90 percent in the visible part of the spectrum were obtained. The optical bandgap of these films is 3.4 eV under room temperature. The Hall effect measurement of ITO films indicates that the values for the Hall mobility of  $\mu_H = 94 \text{ cm}^2\text{V}^{-1}\text{s}^{-1}$  and the carrier concentration of  $N = 3.9 \times 10^{-9}\text{cm}^{-3}$  can be achieved by the electron beam technique.

These ITO films have been used for backwall heterojunction Cds-Cu<sub>2</sub>S solar cells.

\*Received on 27 January 1983.

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ORG: First Branch, Beijing Industrial University

TITLE: "Studies of Replica Techniques of Sputtering Carbon Thin Film"

SOURCE: Beijing ZHENKONG KEXUE YU JISHU [VACUUM SCIENCE AND TECHNOLOGY]  
in Chinese Vol 4 No 4, Jul 84 pp 250-253

TEXT OF ENGLISH ABSTRACT: By using the direct current sputtering or magnetron sputtering methods, techniques for preparing carbon replicas for transmission electron microscopy have been studied in carbon steels and alloy steels. These new methods have a series of good points: the apparatus is simple, ease of operation, the film is tight and resolution is high. Thus, they are of certain practical value.

9717

CSO: 4009/1067

Information Science

AUTHOR: LIU Dongwei [0491 2639 4850]

ORG: Nei Monggol Research Institute of Science and Technology

TITLE: "Three-Dimensional Structure of the National Information System"

SOURCE: Harbin QINGBAO KEXUE [INFORMATION SCIENCE] in Chinese Vol 5 No 5,  
15 Oct 84 pp 38-44

ABSTRACT: The article explores the rules of better exploiting the functions of the national information system as a whole, beginning with the system structure, to remove irrational defects of the national system for closer adaptation to the random requirements of the outside environment. There is a need for studies on the information system engineering--from the aspects of level, structure and function. Based on the system engineering activity matrix of Dr A. D. Hall of Bell Telephone and the systems engineering three-dimensional structure of Joseph Baedeker, the author proposes a three-dimensional structure model of level, logic and condition dimensions in a national information system. The practicality of this model is discussed. The three independent and correlated dimensions are the systems concept and its application, method and technique, as well as natural and social sciences shown in one of three figures in the article. The level dimension consists of longitudinal and lateral organs: comprehensive, professional and Academy of Sciences information systems for the longitudinal arrangement, as well as intelligence network stations, scientific research, educational and economic information systems for the lateral arrangement as shown in another figure. The logic and condition dimensions of the Hall matrix are shown in the only table with literature references, search and retrieval, information investigation and study, compilation and publication, as well as study of information theory as the condition dimension; target, message, design, decision, execution, supervision and feedback as the logic dimension. The remaining figure shows a functional structure model of the national intelligence system.

10424  
CSO: 4009/1065

Information Science

AUTHOR: YE Pinhui [5509 0756 6540]

ORG: None

TITLE: "Views on Reform in Science and Technology Information Activities in China in a Discussion With Yang Yunjun"

SOURCE: Harbin QINGBAO KEXUE [INFORMATION SCIENCE] in Chinese Vol 5 No 5, 15 Oct 84 pp 48-54

ABSTRACT: This article serves as a critique to the article, "On Reform of China's Science and Technology Information Work," on QINGBAO KEXUE, Vol 4 No 4, 1983 by Yang Yunjun [2799 6663 0971] of Chongqing Architecture College. The author searches for contradictions in Yang's article, such as learning from abroad, digesting but not copying foreign experience; a strong attack is launched on Yang's disdain toward the unique domestic information investigation and study. Both authors are quite subjective in their language. Yang points to the undesirable trend of all-inclusive subject areas and scope of work among Chinese academic circles; the author disputes Yang's viewpoint about the former's Soviet influence. On the whole, the author advocates gradual improvements through domestically adaptable small steps in contrast to Yang's drastic reform. An objective discussion on what is wrong with current information activity appears to be what is needed, not the picking of words and defending one's viewpoint by using famous quotations.

10424

CSO: 4009/1065

Information Science

AUTHOR: CHEN Aifen [7115 1947 5358]

ORG: Institute of Subtropical Forestry, Chinese Academy of Sciences

TITLE: "Viewpoints on Developing an Information Organization of Science and Technology"

SOURCE: Harbin QINGBAO KEXUE [INFORMATION SCIENCE] in Chinese Vol 5 No 5, 15 Oct 84 pp 45-47, 44

ABSTRACT: This article describes the status and function of information in scientific research and technological development. Generally speaking, old personnel are experienced and knowledgeable, skillful in information research and capable of providing guidance for middle-aged and young personnel. Middle-aged personnel are decisive, and good in information analysis and collection. Young personnel are vigorous and well adapted to auxiliary work and literature management. These three groups should be properly organized to constitute a well, smoothly run organization. Problems of training, job designation and compensation of information personnel should be properly handled. Education is not the only criterion for job qualification; on-the-job training is at least as important if not more so. Here teamwork is the key to performance as it is currently below par owing to noncooperation among those mostly middle-level information personnel. Upgrading personnel quality is an important measure for augmenting personnel ranks; foreign language, professional training, information theory and library science are vital for information personnel. Summing up, the author made five reform suggestions more or less along the lines in the article.

10424

CSO: 4009/1065

Information Science

AUTHOR: XIAO Zigao [5618 2737 7559]

ORG: None

TITLE: "Trends in the Growth of Abstract Journals in China"

SOURCE: Harbin QINGBAO KEXUE [INFORMATION SCIENCE] in Chinese Vol 5 No 5,  
15 Oct 84 pp 55-58

ABSTRACT: The author studies the growth, transition and present state of China's abstract journals. He recognizes that the transition from translation to compilation was completed in the growth of these journals in China. The current goal is to upgrade journal quality with an unified leadership to compile one or two large, comprehensive and authoritative abstract journals of world-class level. Two tables list the publication of abstract journals from 1954 through 1983 (76 volumes in 49 issues) in China, and translation journals from 1954 through 1960. The author suggests selective translation, use of xerox copies, imported magnetic tapes for computer search and retrieval, and training of amateur abstracters. Especially, computers can shorten time lag and lower publication costs; these developments should be vigorously pursued.

10424

CSO: 4009/1065

Information Science

AUTHOR: DU Yi [2629 3015]

ORG: Information specialty, Department of Library Science, Beijing University

TITLE: "Development and Reform of Information Services in China--Coping With New Technology and Literature Information Work"

SOURCE: Harbin QINGBAO KEXUE [INFORMATION SCIENCE] in Chinese No 6, 15 Dec 84 pp 81-88, 80

ABSTRACT: The author outlines steps on improved services for economic, scientific and technical progress as given by scientific and technological information. He systematically urges reform measures in China's information services along the four aspects of service structure, organization management, service function and technical conditions. An intermediate type of literature information service is suggested between the dispersed American type and the centralized Soviet type, aiming at the benefits of both worlds by setting up a national science and technology information bureau, a national service center, regional centers, and consultation agencies. Thus, national and users' interests can be catered to with open discussions in order to correct work deviations promptly as they may occur from time to time. An information service public law should be promulgated to regulate the party's leadership, the rights of the masses, and promotion of the uses of information. In addition, information and fund allocations, personnel organization, work rules and international (and domestic) exchanges are stipulated. Consultation service and user cultivation-training along the line of commercial information as developed in the United States should be adapted to China with translation and compilation. The network information service structure should use computer automation techniques for search and information retrieval. Here inputting Chinese characters into the computer is the key problem. One figure shows a prototype of China's unique network of information agencies.

10424

CSO: 4009/1066

AUTHOR: DU Baoxun [2629 1405 8113]

ORG: Institute of Semiconductor, Academia Sinica

TITLE: "Theoretical Analysis of Bistable Semiconductor Lasers"

SOURCE: Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 5, No 6,  
Jun 85 pp 528-532

TEXT OF ENGLISH ABSTRACT: A theoretical analysis of hysteresis is presented on bistable semiconductor lasers. First, characteristics of gain and loss are discussed, followed by deduction of the basic formula according to threshold conditions. The formula is then used in a quantitative description of the hysteresis and its dependence on temperature. As a typical example, calculations are carried out for a GaAs-AlGaAs device.

12949

CSO: 4009/275

AUTHOR: WANG Runwen [3769 3387 2429]  
YE Chao [0673 6389]

ORG: Shanghai Institute of Optics and Fine Mechanics, Academia Sinica

TITLE: "SHG for Materials with Absorption Loss and Amplification Gain"

SOURCE: Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese  
Vol 12, No 7, 20 Jul 85 pp 385-394

TEXT OF ENGLISH ABSTRACT: A detailed discussion on the SHG is given for the materials with absorption loss and amplification gain. Using the approximation method, the analytical solution is obtained and compared with the numerical calculation of the coupling equations.

12949

CSO: 4009/282

Physics

AUTHOR: GUO Guangcan [6753 0342 3503]  
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ORG: Department of Physics, China University of Science and Technology

TITLE: "Determination of Anisotropic Properties in the Active Medium"

SOURCE: Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese  
Vol 12, No 7, 20 Jul 85 pp 395-398

TEXT OF ENGLISH ABSTRACT: We have deduced the motion equation for Stokes parameters which describe the polarization state of a light wave as it propagates in an active medium. The method to determine the characteristic vectors indicating the specific anisotropic properties of the medium is also proposed.

12949  
CSO: 4009/282

Lasers

AUTHOR: JIN Huishu [6855 1920 3219]  
ZHAO Yanzeng [6392 3601 2582]

ORG: Institute of Atmospheric Physics, Academia Sinica

TITLE: "Theoretical Analyses on Spectral Characteristics of Electro-optically Tuned Ruby Lasers"

SOURCE: Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese  
Vol 12, No 7, 20 Jul 85 pp 402-407

TEXT OF ENGLISH ABSTRACT: On the basis of rate equations, numerical experiments on the dynamic process of the photon density spectrum evolution in electro-optically tuned ruby lasers with dye Q-switching have been carried out. The effects of dye Q-switching and resonant frequency selector (RFS) on wavelength characteristics is analyzed and the dye switch plays an especially important role in mode selection and line width narrowing.

12949  
CSO: 4009/282

Lasers

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et al.

ORG: Shanghai Institute of Optics and Fine Mechanics, Academia Sinica

TITLE: "Possibility of Continuously Tuning of CO Laser at High Pressure"

SOURCE: Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese  
Vol 12, No 7, 20 Jul 85 pp 408-411

TEXT OF ENGLISH ABSTRACT: On the basis of gain coefficient calculation it is shown that the frequency of the CO laser cannot be continuously tuned over 5~8  $\mu\text{m}$  region by means of increasing its pressure because of the resonant absorption of the R and P branches.

12949  
CSO: 4009/282

Lasers

AUTHOR: FANG Shugan [2455 2579 3227]  
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ORG: Shanghai Jiaotong University

TITLE: "Study of  $F_A$  (III) Centers in  $Tl^+ : KCl$  Single Crystals"

SOURCE: Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese  
Vol 12, No 7, 20 Jul 85 pp 412-414

TEXT OF ENGLISH ABSTRACT: The  $F_A$  (III) centers have been obtained by X-ray irradiation and light conversion in  $Tl^+ : KCl$  single crystals, its emission band lies from 1.3 to 1.7  $\mu m$  and 0.9 to 1.2  $\mu m$  with peaks at 1.5  $\mu m$  and 1  $\mu m$  respectively (77K). The light and thermal stability (R. T) of  $F_A$  (III) centers decreases slowly in the first few days, and then remains unchanged, the stable  $F_A$  (III) centers can be finally obtained.

12949

CSO: 4009/282

Lasers

AUTHOR: GAO Qixiao [7559 0796 1321]

ORG: Naval Engineering Institute

TITLE: "A Measurement Method for High Reflectivity With Two Beams and a Single Detecting Channel"

SOURCE: Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 12, No 7, 20 Jul 85 pp 415-419

TEXT OF ENGLISH ABSTRACT: A new method for measuring high reflectivity and transmissivity is given, with which the effect of both fluctuation of light source and nonlinearity of the detecting system on the accuracy of measurement can be cancelled out. The repeatability is better than  $\pm 1 \times 10^{-4}$  at 6328 Å and  $\pm 5 \times 10^{-4}$  at 1.15  $\mu\text{m}$  respectively.

12949

CSO: 4009/282

Lasers

AUTHOR: SHAN Zhenguo [0830 2182 0948]

ORG: Shanghai Institute of Optics and Fine Mechanics, Academia Sinica

TITLE: "Real-time Measurement of Lasing Spectrum of Semiconductor Lasers"

SOURCE: Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese  
Vol 12, No 7, 20 Jul 85 pp 420-423

TEXT OF ENGLISH ABSTRACT: This paper describes a new method for real-time measurement of lasing spectrum of semiconductor lasers (ES method for short). It is useful particularly for studying characteristics of longitudinal modes and thermal and aging properties of semiconductor lasers.

12949

CSO: 4009/282

AUTHOR: FENG Dexing [7458 1795 5281]  
ZHU Guangtian [2612 1639 3944]

ORG: Institute of Systems Science, Academia Sinica

TITLE: "On Optimal Design of Scattering-Fission Cross Sections"

SOURCE: Beijing XITONG KEXUE YU SHUXUE [JOURNAL OF SYSTEMS SCIENCE AND MATHEMATICAL SCIENCES] in Chinese Vol 5, No 1, Jan 85 pp 73-80

TEXT OF ENGLISH ABSTRACT:

This paper is concerned with optimal design of the scattering-fission cross section of a nuclear reactor, based on a monoenergetic steady-state isotropic transport equation. The existence and uniqueness of an optimal scattering-fission cross section are shown and the corresponding optimality conditions are given. (Paper received on 16 Jul 84)

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12949

CSO: 4009/1087

Mathematics

AUTHOR: HU Shunju [5170 7311 5468]

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TITLE: "On the Spectrum of an Energy-Dependent Neutron Transport Operator"

SOURCE: Beijing XITONG KEXUE YU SHUXUE [JOURNAL OF SYSTEMS SCIENCE AND MATHEMATICAL SCIENCES] in Chinese Vol 5, No 1, Jan 85 pp 10-14

TEXT OF ENGLISH ABSTRACT:

We consider a homogeneous medium sphere with the assumption that the scattering of neutrons is isotropic and the principle of detailed balance holds. Using the operator theory of Hilbert space, we prove that the energy-dependent transport operator has infinite denumerable real eigenvalues which have a unique accumulation point at  $-\infty$ .  
(Paper received on 25 Feb 85)

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CSO: 4009/1087

Mathematics

AUTHOR: LIU Guizhen [0491 2710 4176]

ORG: Shandong University

TITLE: "An Algorithm for Lexicographically Generating Ordered Rooted Trees"

SOURCE: Beijing XITONG KEXUE YU SHUXUE [JOURNAL OF SYSTEMS SCIENCE AND MATHEMATICAL SCIENCES] in Chinese Vol 5, No 1, Jan 85 pp 15-19

TEXT OF ENGLISH ABSTRACT:

Denote the ordered rooted trees by 0,1-sequences. An algorithm for generating these trees with  $n$  nodes lexicographically is described. It is shown that this algorithm can also generate all regular binary trees with  $n$  leaves. A one-to-one correspondence between all the ordered rooted trees with  $n$  nodes and all the regular binary trees with  $n$  leaves is established. So a formula on the number of all the ordered rooted trees with  $n$  nodes is derived. (Paper received on 8 Jun 84)

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12949

CSO: 4009/1087

AUTHOR: WANG Renguan [3076 0088 1351]

ORG: Beijing University

TITLE: "Composite Operating Characteristics of Adjusting Sampling Scheme with Discontinuation"

SOURCE: Beijing YINGYONG SHUXUE XUEBAO [ACTA MATHEMATICAE APPLICATAE SINICA] in Chinese Vol 8, No 1, Jan 85 pp 84-92

TEXT OF ENGLISH ABSTRACT:

The composite operating characteristics function of a sampling scheme including tightened, normal and reduced plans together with an entire switching procedure involving the discontinuation of inspection, such as MIL-STD-105D, hasn't been solved.

This paper develops an expression for the expectation of the lots inspected under various plans, using the binary first transition probability generating function. As an example, we get the composite OC function of MIL-STD-105D using the expression.

In addition, a general approach to determining the composite OC function of a sampling scheme with discontinuation using Markov chain is discussed. (Paper received on 5 Jan 83 and finalized on 15 Sep 83)

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CSO: 4009/1089

Mathematics

AUTHOR: JING Zhujun [0064 4554 0689]

ORG: Institute of Mathematics, Academia Sinica

TITLE: "Qualitative Analysis of a Triple-Molecule Model"

SOURCE: Beijing YINGYONG SHUXUE XUEBAO [ACTA MATHEMATICAE APPLICATAE SINICA]  
in Chinese Vol 8, No 1, Jan 85 pp 111-114

TEXT OF ENGLISH ABSTRACT:

In this paper we make use of the qualitative method of differential equation (1) to study a problem that occurs in the study of a triplemolecules model. We obtain the existence and uniqueness of the periodic solution of Eq. (1) and estimate the position of the periodic solution. (Paper received on 24 Apr 83)

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12949

CSO: 4009/1089

Mathematics

AUTHOR: DU Dingzhu [1035 0002 2691]

ORG: Institute of Applied Mathematics, Academia Sinica

TITLE: "A Gradient Projection Algorithm for Nonlinear Constraints"

SOURCE: Beijing YINGYONG SHUXUE XUEBAO [ACTA MATHEMATICAE APPLICATAE SINICA]  
in Chinese Vol 8, No 1, Jan 85 pp 7-16

TEXT OF ENGLISH ABSTRACT:

We give a new algorithm for nonlinear programming problems with nonlinear constraints. This algorithm belongs to gradient projection methods and is globally convergent the technique used to select projection hyperplanes plays an important role.

(Paper received on 18 Sep 82)

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CSO: 4009/1089

Mathematics

AUTHOR: LIU Dingyuan [0491 7844 0337]

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TITLE: "Rational Bezier Curves"

SOURCE: Beijing YINGYONG SHUXUE XUEBAO [ACTA MATHEMATICAE APPLICATAE SINICA]  
in Chinese Vol 8, No 1, Jan 85 pp 70-83

TEXT OF ENGLISH ABSTRACT:

In this paper, we obtain the distribution theorem for inflexion points and singular points of a cubic rational Bézier curve in an affine plane, so that the geometric shape of the curve can be controlled. To prove the theorem, the projective invariant method for the cubic parametric curve in a projective plane is used. (Paper received on 30 Dec 82)

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CSO: 4009/1089

Mathematics

AUTHOR: LOU Shiyu [5012 6108 5940]

ORG: Chongqing Jiaotong Institute

TITLE: "Dynamic Stability on a 3-folded Symmetrical Spiral Sector Cyclotron"

SOURCE: Beijing YINGYONG SHUXUE XUEBAO [ACTA MATHEMATICAE APPLICATAE SINICA]  
in Chinese Vol 8, No 1, Jan 85 pp 115-120

TEXT OF ENGLISH ABSTRACT:

In the paper the dynamic stability for a 3-folded symmetrical spiral sector cyclotron is analyzed by using the asymptotic method of nonlinear mechanics, and the critical parameters are derived by using Routh-Hurwitz criterion. (Paper received on 5 Jan 82 and finalized on 11 Oct 84)

References

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12949

CSO: 4009/1089

Mathematics

AUTHOR: DANG Xinyi [8093 2450 4135]

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TITLE: "Criteria for Absence of Closed Trajectories of a Three-Dimensional Autonomous System"

SOURCE: Beijing YINGYONG SHUXUE XUEBAO [ACTA MATHEMATICAE APPLICATAE SINICA] in Chinese Vol 8, No 1, Jan 85 pp 121-124

TEXT OF ENGLISH ABSTRACT:

For the system

$$\frac{dx}{dt} = X, \frac{dy}{dt} = Y, \frac{dz}{dt} = Z,$$

if the functions on the right-hand side of (1) in  $G$  satisfy some conditions, then the absence of closed trajectories (or positively oriented or negatively oriented of (1) in  $G$  follows. Concrete examples are given. (Paper received on 14 Oct 83; and as a brief on 5 Sep 84)

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12949

CSO: 4009/1089

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TITLE: "Generalization of the Second-order Coupled-wave Theory of Diffractions on Planar Dielectric Gratings"

SOURCE: Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 5, No 6, Jun 85 pp 488-495

TEXT OF ENGLISH ABSTRACT: A generalization of the second-order coupled-wave theory of diffractions on planar dielectric gratings are presented. The theoretical analysis is rigorously based on the static Maxwell's equations. Therefore, it is easy, in principle, to obtain accurate results by following the computational method given by the present paper.

The planar dielectric gratings studied in this paper are only required to have planar isoplanes and plane surfaces. As the direction of the illuminating wave with respect to the grating is not restricted, the incident plane may be arbitrarily polarized and a series of Jone's matrices are adopted to characterize the grating. This means that gratings are also considered as elements which change the state of polarization of light waves.

12949  
CSO: 4009/275

Optics

AUTHOR: LIU Liren [0491 4539 0086]

ORG: Shanghai Institute of Optics and Fine Mechanics, Academia Sinica

TITLE: "Study of Phenomena of Interference with Extended White Light Illumination by Backward Impulse Response"

SOURCE: Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 5, No 6, Jun 85 pp 481-487

TEXT OF ENGLISH ABSTRACT: By means of the backward impulse response the phenomenon of grating imaging, wherein a grating is imaged by a second one, is analyzed. As a special case, Lau effect is explained thoroughly. The mathematics is simpler while the physical meaning becomes clearer than in the case of other explanations.

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CSO: 4009/275

Optics

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TITLE: "Cyclotron Radiation From Laser Plasma"

SOURCE: Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 5, No 6,  
Jun 85 pp 496-504

TEXT OF ENGLISH ABSTRACT: The cyclotron radiation emitted from electrons in cyclotron motion under influences of the electromagnetic field is investigated. According to a moderate estimation of the emitted energy, the magnitude of cyclotron radiation from the laser plasma is comparative to that of Bremsstrahlung radiation. This result justifies a further study of such phenomenon.

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CSO: 4009/275

Optics

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TITLE: "New Type Two-wave Interaction in Saturable Dye"

SOURCE: Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 5, No 6,  
Jun 85 pp 562-563

TEXT OF ENGLISH ABSTRACT: We have observed a new-type interaction of two non-collinear laser beams with the same frequency in saturable dye solution-bis-(4-dimethyl aminodithio benzil) (BDN) and pentamethine cyanine. It differs from the four-wave mixing, the so-called transient self-diffraction and coherent coupling effects.

12949  
CSO: 4009/275

Optics

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ORG: Shanghai Institute of Laser Technology

TITLE: "Stimulated Raman Scattering in Multimode Optical Fibers Pumped at 1.32  $\mu\text{m}$ "

SOURCE: Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 5, No 6, Jun 85 pp 533-536

TEXT OF ENGLISH ABSTRACT: Generation of wideband Raman scattering spectra in multimode optical fibers, pumped by an 1.32  $\mu\text{m}$  A-O Q-switched Nd:YAG laser, is reported. Discussion shows that the spectra are generated by stimulated Raman scattering and four-photon mixing. Results show that considerable optical continuum is formed because 1.32  $\mu\text{m}$  pumping and its Stokes component are near the zero-material-dispersion range of fibers. A new amplification phenomena of the small 1.34  $\mu\text{m}$  output of the laser in fibers is observed. It is considered that the amplification comes from the wideband Raman gain of the glass optical fibers.

12949  
CSO: 4009/275

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TITLE: "SO(10)xSO(8) Model With Fractional Charges; Monopoles and Peculiar Photons"

SOURCE: Beijing GAONENG WULI YU HE WULI [PHYSICA ENERGIAE FORTIS ET PHYSICA NUCLEARIS] in Chinese Vol 9, No 4, Jul 85 pp 421-429

TEXT OF ENGLISH ABSTRACT: An SO (10)xSO (8) model of grand unified theory is proposed. It can accommodate the color single particles with fractional charges (for example:  $e/2$  or  $e/3$ ), and the model satisfies the Dirac quantization rule with magnetic charge  $1/2e$ . This theory predicts four generations of ordinary fermions and four generations of peculiar fermions. In particular, there exist peculiar photons which are different from ordinary photons. These could be tested in future experiments at high energy.

12949  
CSO:4009/283

Physics

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TITLE: "The Shell Effect in Sequential Fission Induced By  $^{238}\text{U}$  With Energy Just Above Coulomb Barrier"

SOURCE: Beijing GAONENG WULI YU HE WULI [PHYSICA ENERGIAE FORTIS ET PHYSICA NUCLEARIS] in Chinese Vol 9, No 4, Jul 85 pp 454-460

TEXT OF ENGLISH ABSTRACT:

The experimental results of sequential fission are presented for collision of  $^{238}\text{U}$  (5.4 MeV/u) on  $^{48}\text{Ca}$ ,  $^{45}\text{Sc}$  and  $^{238}\text{U}$  (6.0 MeV/u) on  $^{16}\text{O}$ ,  $^{27}\text{Al}$ ,  $^{48}\text{Ca}$ ,  $^{45}\text{Sc}$ ,  $^{48}\text{Ti}$ ,  $^{58}\text{Fe}$ ,  $^{64}\text{Ni}$  and  $^{89}\text{Y}$  targets. The measurements of ternary events in exit channel have been performed by triple coincidence among 4 PPAC with area of 20 cm $\times$ 30 cm. The reconstruction of ternary events are performed by direct kinematics and the fission partner among three fragments is identified by relative velocities between them. The detection geometry efficiency is determined by a Monte-Carlo simulation.

Before the sequential fission, U-like fragments are scattered near grazing angle. The most probable value of TKEL in the scattering process associated with S. F. changes from 25 MeV to 55 MeV for different reaction systems. The angular distributions of debris of S. F. in second C. M. are isotropic.

In conclusion, because of lower fission threshold at Uranium region, the sequential fission mainly follows quasielastic scattering, in S. F. cross-section  $\sigma_{S.F.}$ , there is strong shell effect. A simple relationship between  $\sigma_{S.F.}$  over  $\sigma_R$ , the total reaction cross-section and Sommerfeld parameters S for nuclei with magic number are obtained.

12949  
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Physics

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TITLE: "Quark Confinement Potential and Color Van Der Waals Force"

SOURCE: Beijing GAONENG WULI YU HE WULI [PHYSICA ENERGIAE FORTIS ET PHYSICA NUCLEARIS] in Chinese Vol 9, No 4, Jul 85 pp 467-475

TEXT OF ENGLISH ABSTRACT: The color-analog Van der Waals force between two hadrons is studied by the use of the coupling channel resonating group method in the framework of the Gaussian-type quark confinement potential. The problem of the boundary values for the two channel coupling differential equations is changed to the problem of the initial values. The equations are solved numerically by the use of the Gear method. The calculated results show that there is no color Van der Waals force between hadrons in the confinement potential model. This indicates that the confinement potential model not only can describe the internal structure of hadrons but also can be used to calculate the hadron-hadron interactions if the quark confinement potential is chosen properly.

12949  
CSO: 4009/283

Physics

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et al.

ORG: Institute of High Energy Physics, Academia Sinica

TITLE: "The Performance of a Large Area Plastic Scintillation Counter for TOF Measurement"

SOURCE: Beijing GAONENG WULI YU HE WULI [PHYSICA ENERGIAE FORTIS ET PHYSICA NUCLEARIS] in Chinese Vol 9, No 4, Jul 85 pp 498-501

TEXT OF ENGLISH ABSTRACT: A large area plastic scintillation counter (100\*20\*1cm<sup>3</sup>) for TOF measurement has been made and the performance of this counter has been measured. A self researched new type Mean-Timer was used to much better eliminate the time difference of the fluorescence light transmission in the scintillator generated by the different location of the injecting particles, and obtained time resolution of scintillation counter is about 347 ps.

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