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RESISTANCE OF DIELECTRIC COATINGS OF LEAD OXIDE AND CRYOLITE TO LASER RADIATION

by

N. L. Kramarenko, Yu. V. Naboykin, Yu. A. Tiunov

EDITED TRANSLATION

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Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere. When written as ё in Russian, transliterate as yё or ё. The use of diacritical marks is preferred, but such marks may be omitted when expediency dictates.

GREEK ALPHABET

Alpha	Α	α	*α*		Nu	Ν	ν	
Beta	Β	β			Xi	Ξ	ξ	
Gamma	Γ	γ			Omicron	Ο	ο	
Delta	Δ	δ			Pi	Π	π	
Epsilon	Ε	ε	ϵ		Rho	Ρ	ρ	ϱ
Zeta	Ζ	ζ			Sigma	Σ	σ	ς
Eta	Η	η			Tau	Τ	τ	
Theta	Θ	θ	ϑ		Upsilon	Τ	υ	
Iota	Ι	ι			Phi	Φ	φ	ϕ
Kappa	Κ	ϰ	κ	*ϰ*	Chi	Χ	χ	
Lambda	Λ	λ			Psi	Ψ	ψ	
Mu	Μ	μ			Omega	Ω	ω	

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English
sin	sin
cos	cos
tg	tan
ctg	cot
sec	sec
cosec	csc
sh	sinh
ch	cosh
th	tanh
cth	coth
sch	sech
csch	csch
arc sin	$\sin^{-1}$
arc cos	$\cos^{-1}$
arc tg	$\tan^{-1}$
arc ctg	$\cot^{-1}$
arc sec	$\sec^{-1}$
arc cosec	$\csc^{-1}$
arc sh	$\sinh^{-1}$
arc ch	$\cosh^{-1}$
arc th	$\tanh^{-1}$
arc cth	$\coth^{-1}$
arc sch	sech^{-1}
arc csch	csch^{-1}

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rot	curl
lg	log

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RESISTANCE OF DIELECTRIC COATINGS OF LEAD OXIDE AND CRYOLITE TO LASER RADIATION

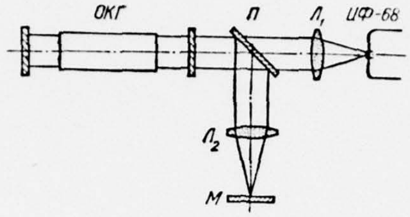
N. L. Kramarenko, Yu. V. Naboykin, Yu. A. Tiunov

In connection with the continuous development of investigations in the field of lasers, the need increases for dielectric coatings serving as resonator mirrors. The main requirements, which are imposed on such coatings, are high reflecting properties and resistance to laser radiation, especially with high energy densities.

Existing mirrors on a base of zinc sulfide and various fluorides possess sufficiently high strength and high coefficients of reflectivity. However, substances are known for which the refractive indices are higher than for zinc sulfide. This makes it possible to produce mirrors from a smaller number of layers with the same parameters than for mirrors from zinc sulfide. Such substances include lead oxide.

In this article by means of the application of alternating layers of lead oxide and cryolite in a vacuum we obtained multilayer mirrors, which were applied as reflectors in a laser resonator. Some optical properties of such multilayers are investigated in [1-3]. In our work we discussed the results of investigation of the resistance of these coatings to ruby laser radiation depending on the method of their preparation and the number of deposited layers. Multilayer coatings of lead oxide and cryolite were obtained by means of vaporization of substances in an ordinary vacuum installation [4] with a rectifier, with which it is possible to regulate the degree of vacuum under the cover. Regulation is necessary since the lead oxide layers are applied with $p \sim 3 \cdot 10^{-4}$ torr [2], and cryolite layers with $p \sim 1 \cdot 10^{-5}$ torr. The rate of pulverization of lead oxide with such a vacuum is approximately 500 Å/min. The refractive index of PbO layers highly depends on the temperature of the backing. So, with temperature 20°C the refractive index for λ =5780 Å is equal to 2.55, and with temperature 200°C n =2.71. The relationship of reflectivity of the lead oxide layers to the temperature of the backing is studied in detail in [3]. We applied the lead oxide layers to the backing at temperature 20 and 200°C. Multilayer coatings from lead oxide and cryolite, applied at different temperatures of backing, for lead oxide were tested for durability against ruby laser radiation, and the coefficients of reflectivity were measured on an instrument, made according to the Dufour scheme [4].

In literature there are practically no data on the resistance of laser reflectors to the action of coherent radiation. In [5] are described the strength characteristics of multilayers of zinc sulfide and magnesium fluoride. As our investigations have shown, it is difficult to systematically evaluate the strength of coatings against radiation because of their surface irregularity and the necessity of using focused laser radiation on some section of the surface. The strength of multilayer coatings was studied by the following method. A ruby laser beam (figure) with maximum output energy ~ 4 J, operating in free-running mode, was focused with lens $Л_1$ on the inlet opening of IF-68 vacuum calorimeter.



The other part of the beam (~ 20%) was separated with the aid of beam splitting plate П and was focused with lens $Л_2$ on multilayer M. For determining the quantity of incident energy on the sample the energy was measured with plate П and without it. Such a scheme of installation gave the possibility of precisely recording the energy of breakdown of the multilayer. A criterion of disturbance of the strength of coating was the appearance of a noticeable spot on its surface. The area of the spot was determined by the following method: it was photographed under a microscope, and then its area was found by weighing the photograph of the contour cut from paper. Thus we determined the maximum density of energy at which the coating was destroyed. We started to irradiate the microlayer with lower energy than the breakdown energy, and gradually brought it to a limiting value, at which the spot appeared on the surface.

(1) Число слоев	(2) Коэффициент отражения, %	(3) W пред, дж/см², при $t_{под}$ = 20° C	(2) Коэффициент отражения, %	(3) W пред, дж/см², при $t_{под}$ = 200° C
1	40	680	44	2100
5	86	500	90	1400
7	95	360	97	1300
9	97	320	99	640

Table key: a. number of layers, b. coefficient of reflectivity, %, c. W_{limit}, J/cm^2, with t_{back}=20°C.

The experimental values of limiting energy densities, at which the coating was destroyed, are provided in the table. These data correspond to values of the breakdown energy, averaged along the surface of the microlayer coating. From the table we see that the strength of multilayer coatings is increased with decrease of the number of layers: so, a ten-layer has density of breakdown energy 320 J/cm^2 and a one-layer - 680 J/cm^2. Multilayers, for which the temperature of backing with the application of lead oxide was 200°C, have a sharper relationship of limiting energy density to the number of layers: for ten-layer the limiting energy density is 640 J/cm^2, and one-layer - 2100 J/cm^2.

Single-layer coatings, for which lead oxide is applied on a hot backing at t=200°C, turned out to be stronger. Heating of the backing, on the one hand, increases the adhesion of the first layer with the backing, and on the other hand decreases the absorption of the multilayer and increases its reflectivity, which leads to the increase of strength.

The energy densities, which multilayer coatings of lead oxide and cryolite withstand, are lower than the densities provided in [5] for multilayers from zinc sulfide and magnesium fluoride. This is apparently connected with the low melting temperature of lead oxide (t=888°C) in comparison with the melting point of zinc sulfide. However, increase of the density of coatings, which is observed with heating of the backing to 200°C, permits having confidence that treatment of the backing can improve the resistance of lead oxide and cryolite coatings to laser radiation.

BIBLIOGRAPHY

1. Набойкин Ю. В., Крамаренко И. Л.— ПТЭ, 1965, 2, 189
2. Clapham P. B.— J. Sci. Instrum., 1962, 39, 596.
3. Набойкин Ю. В., Крамаренко И. Л., Акопов В. М.— Журнал прикладной спектроскопии, 1966, 5, 2, 153.
4. Толанский С. Спектроскопия высокой разрешающей силы. ИЛ, М., 1955.
5. Бонч-Бруевич А. М., Имас Я. А.— Журнал прикладной спектроскопии, 1964, 1, 3, 265.

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