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MANUFACTURING METHODS AND TECHNOLOGY (MM AND T) MEASURE FOR FAB--ETC(U)
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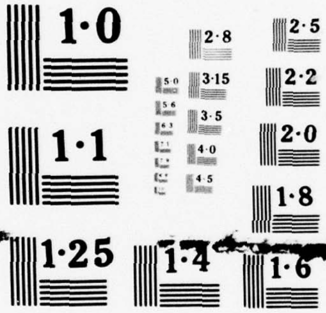

NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

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UNCLASSIFIED

THIRD QUARTERLY PROGRESS REPORT

MANUFACTURING METHODS AND TECHNOLOGY (MM & T) MEASURE FOR FABRICATION OF THIN FILM ALUMINUM OXIDE (Al_2O_3) ION BARRIER 18MM MICROCHANNEL PLATES

(TITLE UNCLASSIFIED)

1 JANUARY 1977 TO 31 MARCH 1977
CONTRACT NO. DAAB07 - 76 - C - 0043

U. S. ARMY ELECTRONICS COMMAND
PRODUCTION DIVISION
PRODUCTION INTEGRATION BRANCH
FORT MONMOUTH, NEW JERSEY 07703

ITT *Electro-Optical Products Division*
7635 Plantation Road, Roanoke, Va. 24019

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

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MMTE FOR Al_2O_3 ION BARRIER MCPs

THIRD QUARTERLY REPORT

CONTRACT NUMBER DAAB07-76-C-0043

Prepared For

PROCUREMENT DIVISION, FORT MONMOUTH
PROCUREMENT AND PRODUCTION DIRECTORATE
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Director of Engineering

ABSTRACT (U)

(U) Effort during the third quarter of the contract was concentrated on fabrication and testing of the second submission of 10 engineering samples. In addition, tasks continued during the report period include: 1) achievement of uniform fire polishing of entire MCP input surface by using a mesh heater structure, 2) improved MCP surface quality by optimizing prepolish condition of MCP's and 3) employment of thicker lacquer films to improve Al_2O_3 quality.

(U) The new Varian evaporator was completed and used to perform all Al_2O_3 evaporations. To achieve better thickness control, a dual shutter system was employed. Several flood gun designs were tested in the present engineering demountable test head to achieve higher electron density for improved viewing of Al_2O_3 film defects.

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1.0 INTRODUCTION (U)

(U) The purchase description DAAB07-76-R-0035 calls for a manufacturing methods and technology measure (MMTE) for "Aluminum Oxide" Al_2O_3 which meet the MCP 003 requirements. The objective of this program is to establish a production capability for the purpose of meeting estimated military needs for a period of two years after completion of the contract, and to establish a base in plans which may be used to meet expanded requirements. The MMTE will include all work under Paragraphs 3.1 and 3.2 of ECIPPR No. 15 necessary to establish capability to manufacture aluminum oxide ion barrier microchannel plates on a pilot line basis including fabrication of engineering samples and confirmatory samples as specified in the contract. Included in this program as part of the engineering phase are the investigation of improvements in surface conditions and cleanliness for MCP's to be filmed, salvage of Al_2O_3 ion barrier MCP's, filming process control, the achievement of optimum performance characteristics for ion barrier MCP's and the design and fabrication of specialized test equipment.

2.0 TECHNICAL DISCUSSION (U)

2.1 Al_2O_3 Ion Barrier Formation (U)

2.1.1 MCP Surface Cleaning (U)

(U) In addition to closer inspection and particle picking of MCP's prior to filming, edge grinding of the polished MCP has been introduced as part of the cleaning process. During the standard polishing process, cerium oxide particles are embedded into the beveled edge of the MCP as it shifts position in the polishing holder during the polishing operation. To remove embedded particles, the polished MCP is edge ground which is accomplished by loading the MCP into a vacuum chuck, rotating the plate and grinding the exposed edge with a honing tool. Edge grinding has resulted in much cleaner plates and has reduced the number of type A and B holes in the Al_2O_3 film.

2.1.2 Improved Lacquering Techniques (U)

(U) Investigations of improved lacquering techniques have included use of an overflow lacquering tank for achieving a cleaner water surface, control of lacquer thickness, and investigation of lacquer set up and drying time.

During the last portion of this quarter, attempts were made to lacquer funneled plates on another program. In filming funneled plates, the lacquer is only supported by very thin edges of the MCP matrix glass. Using the standard lacquering process, lacquer films sagged and ruptured when stretched across the funneled active area of the MCP. Sagging and rupturing was eliminated by employing a thicker lacquer film. Thicker lacquer films can be produced by slightly increasing the temperature of the water bath. Warmer water speeds up the drying process of the lacquer and therefore, limits spreading of the lacquer on the water surface. This technique was successfully used to lacquer and film funneled MCP's.

The same technique was then applied to standard plates and test results have shown that thicker films effectively reduce the number of type A holes in the finished plate.

2.1.3 Al_2O_3 Ion Barrier Evaporation (U)

2.1.3.1 Vacuum Baking of Al_2O_3 Films (U)

(U) Prior to completion of the second submission of engineering samples, it was found that vacuum baking of Al_2O_3 ion barrier MCP's resulted in thinning of the Al_2O_3 film and hence in a reduction in dead voltage and gain change between 800 and 1000 volts input landing energies. The same decrease in dead voltage was measured in tubes after processing in a parallel tube program.

(U) To confirm these results, several ion barrier plates were vacuum baked at 375°C for 8 hours. The test results are shown in Table I.

(U) These test results show that vacuum baking of ion barrier MCP's reduced the thickness of Al_2O_3 ion barrier films. The average reduction in gain change and in dead voltage was 40%. To compensate for the reduction in film thickness during vacuum bake, the thickness of the Al_2O_3 film

Table I (U)

Plate #	Thickness	Prior to Bake Gain Change/ Dead Voltage	After Bake Gain Change/ Dead Voltage
538-11	45 Å	8%/ 80 Vdc	5%/60 Vdc
538-09	47 Å	7.5%/ 85 Vdc	4%/30 Vdc
538-19	42 Å	7.7% 80 Vdc	5%/50 Vdc
538-16	42 Å	6% / 80 Vdc	4%/30 Vdc
538-07	42 Å	5% / 45 Vdc	0%/ 0 Vdc

was increased. Additional MCP's were prepared with a 63 Å thick Al_2O_3 film. The test results, before and after vacuum bake, are shown in Table II.

Table II (U)

Plate #	Thickness	Prior to Bake Gain Change/ Dead Voltage	After Bake Gain Change/ Dead Voltage
317-27	63 Å	15%/ 260 Vdc	5.3%/190 Vdc
538-26	63 Å	16%/ 270 Vdc	11.3%/170 Vdc
317-32	63 Å	18%/ 250 Vdc	16%/ 210 Vdc
317-30	63 Å	16%/ 260 Vdc	15%/ 180 Vdc
317-24	63 Å	15%/ 230 Vdc	13%/ 180 Vdc
317-45	63 Å	15.5%/ 240 Vdc	15%/ 180 Vdc
538-21	63 Å	15%/ 225 Vdc	13.5%/165 Vdc

(U) In contrast to the results shown in Table I, the second experiment yielded a drop in gain change and dead voltage of only 25%.

(U) In addition to the above tests, three MCP's from Table I were rebaked at 375°C for 8 hours. The test results are shown in Table III which show that the second vacuum bake does not affect the gain change and dead voltage appreciably.

Table III (U)

Plate#	Thickness	Prior Bake Gain Change/ Dead Voltage	After Bake Gain Change/ Dead Voltage	After 2nd Bake Gain Change/ Dead Voltage
538-19	42 Å	7.7%/80 Vdc	5%/50 Vdc	4%/ 10 Vdc
538-09	47 Å	7.5%/85 Vdc	4%/30 Vdc	5.8%/ 45 Vdc
538-11	45 Å	8%/ 80 Vdc	5%/60 Vdc	5%/ 50 Vdc

(U) Based on the results shown in Table II additional plates were evaporated with a 55 Å thick Al_2O_3 film. As shown in Table IV, a gain change of slightly less than 10% and a dead voltage of 150 Vdc were achieved after vacuum bake.

Table IV (U)

Plate #	Thickness	Before Bake Gain Change/ Dead Voltage	After Bake Gain Change/ Dead Voltage
542-32	55 Å	10%/200 Vdc	7%/140 Vdc
542-33	55 Å	11%/185 Vdc	9%/140 Vdc

(U) These experiments have shown that the required maximum gain change of 10% and maximum dead voltage of 150V can be met with a 55 Å thick Al_2O_3 film after a vacuum bake at 375°C for 8 hours.

2.1.3.2 Al_2O_3 Film Evaporation With Varian Evaporator. (U)

(U) During this report period, the new oil free Varian Evaporator was made operational. Experiments were performed to establish evaporation conditions and to achieve Al_2O_3 film characteristics with respect to gain change and dead voltage identical to those achieved with Al_2O_3 films prepared with the Veeco evaporator. Identical film characteristics were achieved with a deposited film thickness of 40-42Å as compared to 55Å with the Veeco evaporator. The reduced film thickness may be attributed to the lower vacuum pressure during evaporation. The new evaporator maintains a vacuum pressure of 5×10^{-6} Torr during evaporation as compared to an average of 5×10^{-5} Torr with the Veeco evaporator.

(U) To establish accurate rate control and deposition, a dual shutter system was designed and installed in the Varian evaporator. The dual system consists of a scissors shutter which is located directly below the MCP substrate holder and an evaporant outgassing shutter which is located directly above the E-gun hearth. The"scissors" shutter consists of two semi-circular plates and a circular cutout in the closed position which is in line with the sensor head and the evaporant source. After initial outgassing of the Al_2O_3 evaporant in the evaporation boat, the outgassing shutter is swung open to expose the thickness monitor to the vapor stream. The evaporation rate is then adjusted to 1 to 2Å per second. During this adjustment period, the scissors shutter is in the closed position to protect the MCP's from Al_2O_3 vapors. The outgassing shutter is then moved over the evaporation boat to re-zero the thickness monitor. The scissors shutter is then opened and the outgassing shutter is then quickly swung open. After 40Å of Al_2O_3 have been evaporated, the outgassing shutter and scissors shutter are closed again. This dual shuttering technique has greatly improved Al_2O_3 deposition control. Al_2O_3 films of desired thickness can now be produced on a reproducible basis.

2.2 MCP Surface Quality Improvement (U)

2.2.1 Grinding and Polishing (U)

(U) To improve the pre-polish condition of the MCP surface, twenty-two MCP's were ground with a mixture of 5 micron particle grinding compound and Cerite polishing compound mixed in a ratio of 4:1. MCP surfaces were then polished by utilizing the standard production polishing process. After removal of the core glass in 10% solution of HCl, the surface of the MCP did not reveal any scratches which normally appear at this stage. A photograph of the surface of a standard MCP is shown in Figure #1. Surface scratches can be seen on the matrix of the MCP. As a comparison, Figure #2 shows the etched surface of an MCP which has been prepared with the improved pre-polish technique. No surface scratches can be detected. To confirm these results, a second group of MCP's will be prepared during the 4th quarter with the improved pre-polish technique.

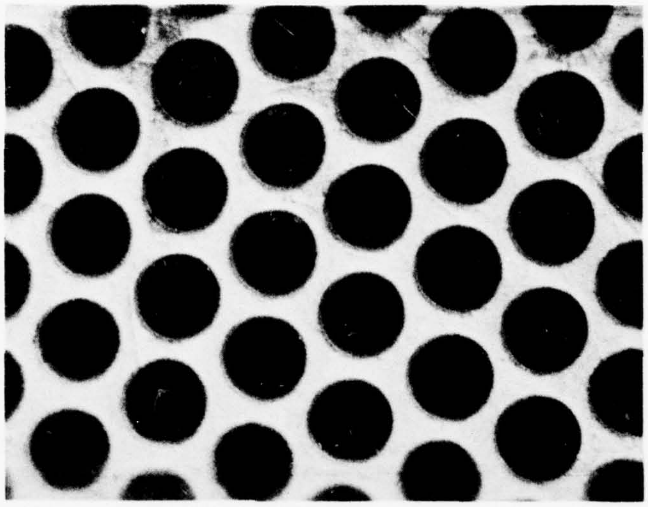


FIGURE #1 (U) Normal Production MCP Surface After Chemical Etching and Cleaning.

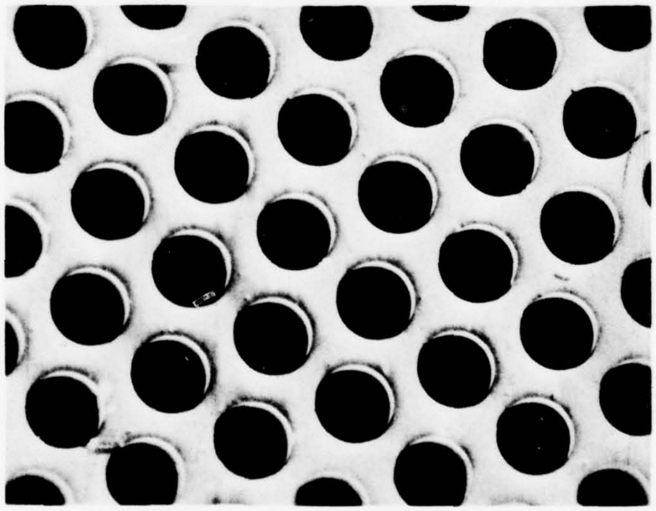


FIGURE #2 (U) Improved "Pre-Polish" Condition MCP Surface After Chemical Etching and Cleaning.

2.2.2 Fire Polishing (U)

(U) Fire polishing experiments were continued utilizing a square tantalum heating mesh. These experiments have produced uniform fire polishing action across the entire MCP surface.

(U) Fire polishing is accomplished in the following manner. The MCP is located in vacuum with a heat source in close proximity to the input side. The heat source is activated which then raises the glass surface to just below the melting temperature. To achieve a smooth and uniform fire polished surface, the temperature is peaked to the melting point and then reduced to room temperature.

(U) This technique has resulted in one uniformly fire polished MCP. However, subsequent experiements have clearly demonstrated that fire polishing conditions are extremely difficult to reproduce. The decision was then made to discontinue this technique in favor of the more successful pre-polish technique.

2.3 Testing of Al_2O_3 Ion Barrier Films (U)

2.3.1 Tube Construction (U)

(U) In preparation for the confirmatory sample phase of the contract, two test tubes were constructed with Al_2O_3 ion barrier MCP's. Both tubes were built using production sub assemblies and utilizing standard Generation II production facilities. Special handling of filmed MCP's was introduced to insure that the Al_2O_3 film was not picked or blown clean during assembly and exhaust loading operations. After both tubes were completed, testing at 5 volts landing energy revealed many more "hole" defects in the Al_2O_3 film than had been detected by the demountable test head using UV excitation of an aluminized quartz cathode as the emission source. The appearance of more holes in the Al_2O_3 film of the finished tubes may be related to tube processing techniques or more holes may be detectable with the higher electron density from the photocathode. To determine if more holes can be detected with higher electron density, the demountable test head was equipped with a flood gun capable of higher electron emission than the presently employed UV excited aluminized quartz cathode.

(U) Both tubes were assembled and exhausted without difficulty. For simplicity, the tubes were assembled using the single seal method and the MCP was outgassed with a standard GEN II flood gun.

2.3.2 Flood Gun MCP Testing (U)

(U) Our present engineering demountable test station is equipped with two test heads. One of the test heads was modified for flood gun viewing of Al_2O_3 filmed MCP's whereas the second test head is equipped with a UV excitation source. A standard GEN II MCP outgassing gun was modified to achieve flood gun electron excitation of the Al_2O_3 ion barrier MCP. Despite employment of a mesh between the flood gun and the test MCP, the uniformity of the flood beam was poor. However, sufficient testing was performed to determine that the flood gun viewing system is capable of detecting all holes which are detectable with the UV excited test head, and in addition, the flood gun viewing system is capable of resolving smaller holes in the film than could be detected with the UV excited test head.

2.3.3 Defect Study Using Thick Al_2O_3 Films. (U)

(U) In an effort to correlate film defects which are detectable by electron viewing with film defects which are visually detectable under the Leitz microscope, MCP's were prepared with thick Al_2O_3 films. One MCP was evaporated with 500Å of Al_2O_3. The second sample was evaporated with 250Å of Al_2O_3. Thicker films facilitate visual detection of very small (2-3 micron) defects in the Al_2O_3 film.

(U) Figure #3 shows a plate when viewed with the flood gun. This MCP was originally rejected in the UV test head for an excessive number of type A and B holes. After rejection, it was re-evaporated with 500 additional Å of Al_2O_3 for defect studies. In Figure #4, the large bright spot appearing near the edge of the MCP at the bottom of the photograph was located visually and photographed using the Leitz microscope. This defect is illustrated in Figure #4, and apparently is a break in the lacquer film exposing an area of at least six single channels. Close examination of the defect revealed a raised edge around the periphery of the defect

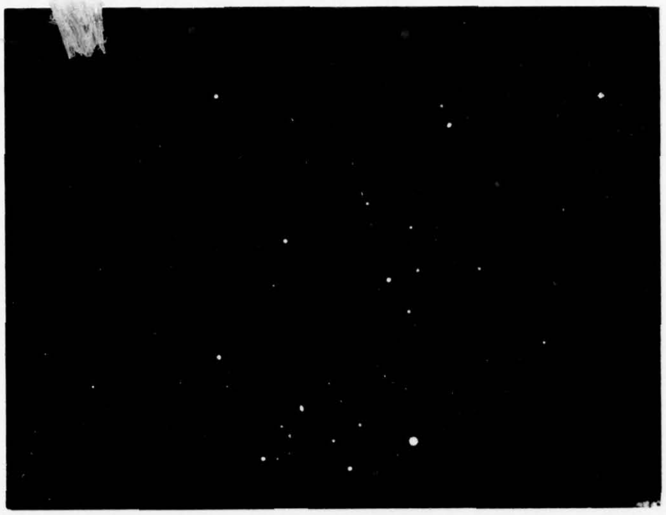


FIGURE #3 (U) Photograph of Reject Al_2O_3. Filmed MCP as Viewed with the Flood Gun Test Head.

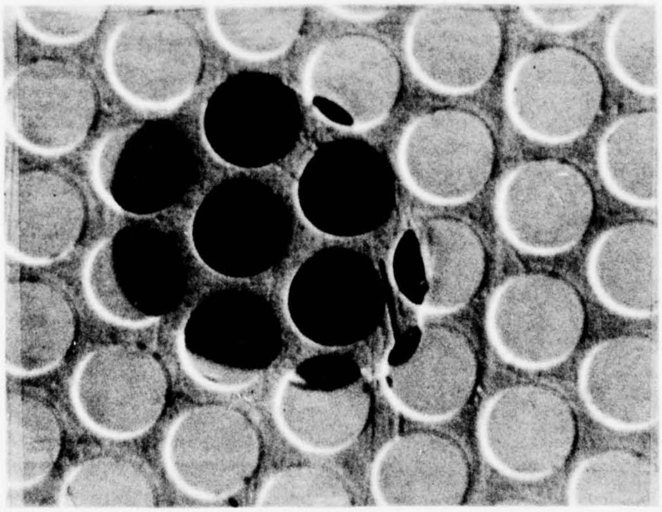


FIGURE #4 (U) Photograph of Large Hole in the Lacquer Film Probably Present Prior to Al_2O_3 Evaporation.

which consists of the rolled lip of the lacquer film. Other defects in thick Al_2O_3 film MCP's are illustrated in Figures 5, 6, and 7. Additional tests will be required to determine and isolate causes for film defects.

2.4 Bakeable and Demountable Vacuum Test System (U)

(U) The demountable system was completely assembled at the end of the third quarter. A photograph of the assembled system is shown in Figure #8. The delayed SCR heat controller has since been received. The entire system is presently undergoing heat and pressure tests.

(U) The entire vacuum system has been leak checked. A nude UHV gauge has been installed in the chamber to permit pressure testing of the demountable chamber during heat cycling. A photograph of the demountable chamber is shown in Figure #9.

(U) After all leak checking at room temperature and at 375°C has been completed, the internal fixturing will be installed. The internal fixturing consists of 1) a fixed circular plate containing either aluminized cathodes or openings for flood gun electrons arranged in a circle, 2) a rotatable plate containing six ceramic nests arranged in a circle and 3) a support stand which locates the six ceramic nests directly below viewing ports which are situated on top of the chamber.

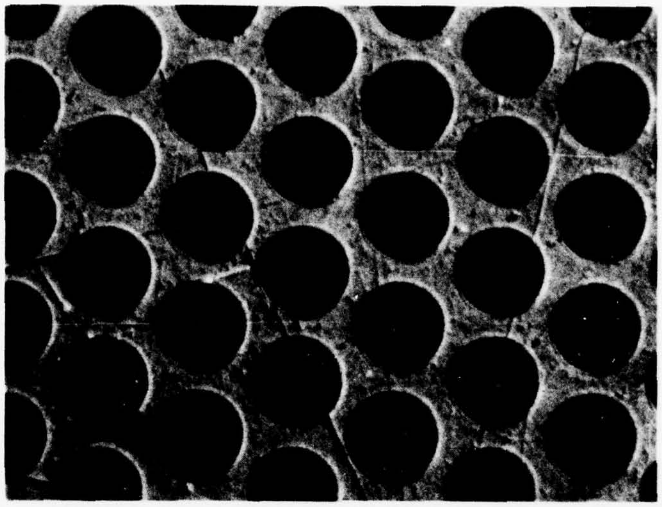


FIGURE #5 (U) Completed MCP With Al_2O_3 Film Illustrating a Small 3-4 Micron Hole in Lacquer Film. Hole May Be Caused by Al_2O_3 "Pop-Up" During Evaporation. Appears as Defect in Demountable.

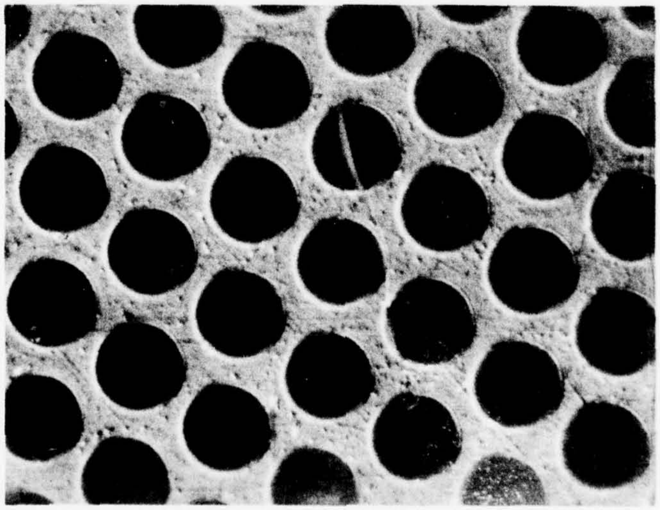


FIGURE #6 (U) Completed MCP With Al_2O_3 Film Illustrating Splits in Lacquer Film. May Be Weakness in Lacquer. Appears as Defect in Demountable.

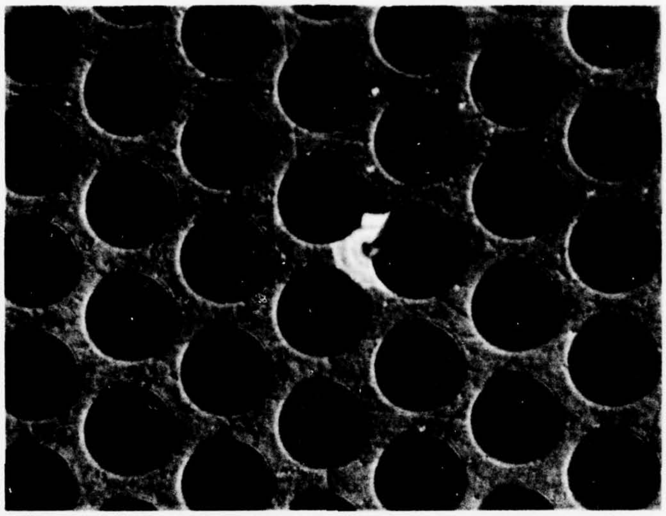


FIGURE #7 (U) Dust Particles Under Al_2O_3 Film. Appears as Defect in Demountable.

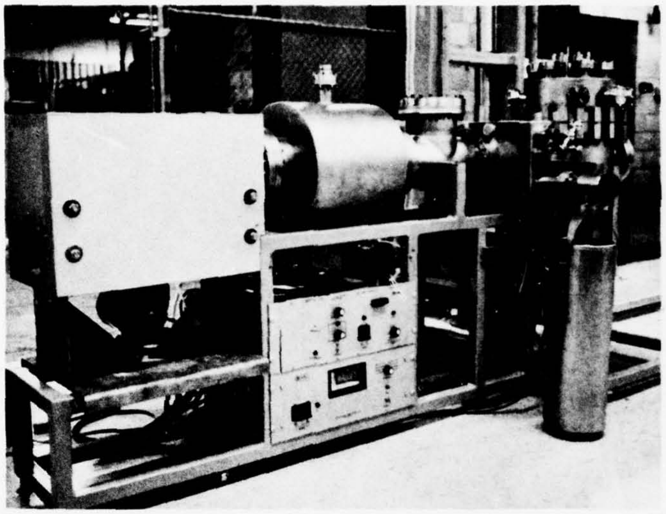


FIGURE #8 (U) Photograph of Test Chamber and Pumping System.

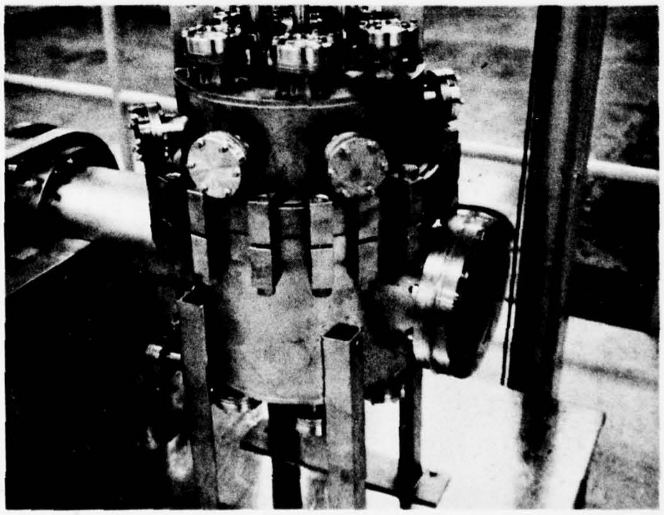


FIGURE #9 (U) Bakeable Demountable Test Chamber.

(U) Each ceramic nest contains a test MCP and a phosphor faceplate which can be rotated over any of the fixed outgas or test positions. This arrangement permits each MCP to be electron scrubbed with a flood gun and tested with either a flood gun or UV excited aluminized cathode for electrical characteristics and ion barrier film quality.

(U) Electrical connections to the MCP input and output, aluminized cathodes and flood gun electrodes are made through the bottom section of the chamber. High voltage connections to the six phosphor plates are already mounted in the top portion of the chamber.

2.5 Preparation and Delivery of Second Submission of 10 Engineering Samples (U)

(U) The second submission of ten (10) engineering samples was submitted on February 28, 1977. Catagory II requirements for these samples include nine non-bake requirements and two requirements after bake. Each MCP after it had been tested and met the nine non-bake requirements was individually loaded into a tube body and baked for 8 hours at 375°C. The vacuum bake requirements for catagory II tests were also met. The MCP's were then retested in the demountable test head for correlation of test results. Test data for the 10 engineering samples are given in Table V. Detailed test data for each MCP are presented in Figures 10 through 19.

(U) The engineering demountable test head and the new bakeable demountable system need to be equipped with

Table V.

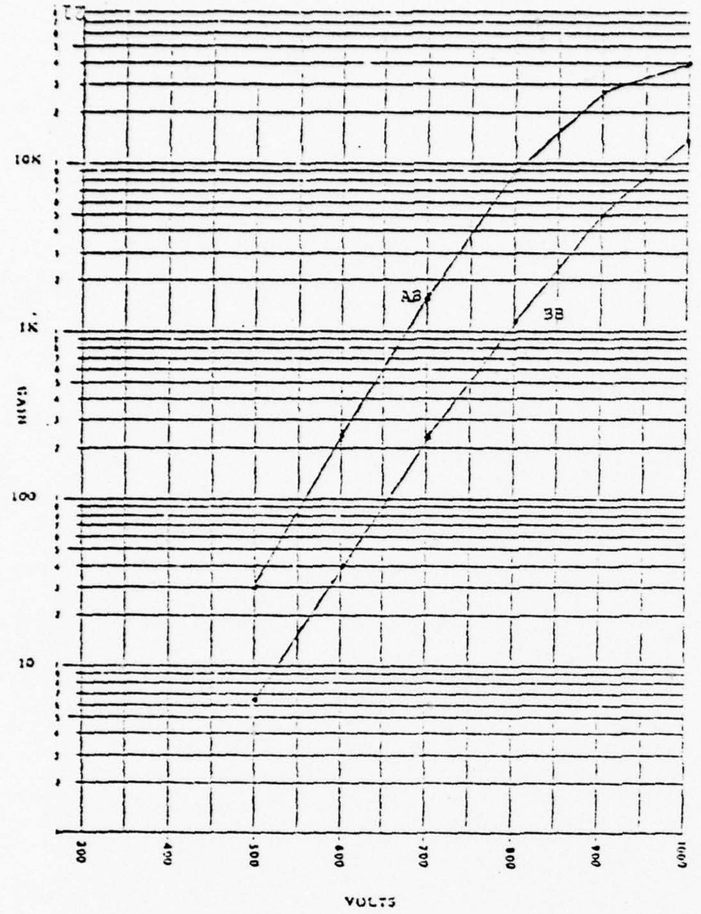
2ND GROUP ENGINEERING SAMPLES

TEST SUMMARY SHEET

MCP-003

3-4-77

REQUIREMENT	3.3.1.1	3.3.1.2	3.3.1.3	3.3.1.4	3.3.1.5.1	3.3.1.5.2	3.3.1.5.3	3.3.1.6.2	3.3.2	3.3.1.7.1	3.3.1.7.3
TEST	4.5.2.1	4.5.2.2	4.5.2.3	4.5.2.4	4.5.2.5.1	4.5.2.5.2	4.5.2.5.3	4.5.2.6.2	4.5.2.1.0	4.5.2.2	4.5.2.4
TITLE	PENETRATION VOLTAGE	GAIN	DARK CURRENT	RESISTANCE ($x10^8$ OHMS)	TYPE A HOLES	TYPE B HOLES	OTHER HOLE DEFECTS	HALATION, HOT SPOTS & FIELD EMISSION	MICROSCOPIC WHISKER GROWTH	GAIN	RESISTANCE ($x10^8$ OHMS)
SPECIFICATION	10% MAX	4000 MIN	$8.5x10^{-16}$ MAX	$1 \rightarrow 5x10^8 \Omega$	30 MAX	5 MAX	0	NONE	NONE	3000 MIN AT 900V	$1 \rightarrow 6x10^8 \Omega$
MCP #											
542-30	8.0	5000	0	3.9	2	2	0	NONE	NONE	28000	3.6
542-33	9.0	8000	0	5.0	3	2	0	NONE	NONE	23666	4.7
542-32	7.0	5000	0	5.0	5	1	0	NONE	NONE	23666	3.0
542-26	10.0	5333	0	3.1	12	1	0	NONE	NONE	19000	3.0
464-T1	7.0	6333	0	4.8	5	1	0	NONE	NONE	14333	4.4
464-T6	7.0	5333	0	3.2	6	1	0	NONE	NONE	23666	2.9
464-T5	8.0	5666	0	3.7	25	1	0	NONE	NONE	24660	3.5
542-19	9.0	7575	0	3.5	15	0	0	NONE	NONE	17270	3.4
542-29	10.0	6333	0	4.0	10	1	0	NONE	NONE	21666	3.8
508-20	8.0	8900	0	5.0	3	2	0	NONE	NONE	19330	4.9



MCP S/N 542-30
VENDOR ITT
DATE TESTED 3-2-77
DIA. 0.975 inches
THICKNESS 21.6 mils

CONDUCTIVITY:	B.B.	A.B.	T.B.	
@ 500V	1.28	1.25	1.1	μ amps
@1000V	2.58	2.78	2.35	μ amps

INPUT: 1.5×10^{-12} AMPS/CM^2

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD
500	2.0 exp- 10	6.6	
600	1.2 exp- 9	40	
700	7.0 exp- 9	233	
800	3.7 exp- 8	1233	
900	1.5 exp- 7	5000	
1000	4.7 exp- 7	15666	0

BEFORE BAKE
800 VEK

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD.
500	9.0 exp- 10	30	
600	8.0 exp- 9	266	
700	5.3 exp- 8	1766	
800	2.75 exp- 7	9166	
900	8.4 exp- 7	28000	
1000	1.2 exp- 6	40000	0

AFTER BAKE
800 VEK

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD.
500	3.7 exp- 11	7.0	
600	3.3 exp- 10	63	
700	2.2 exp- 9	420	
800	1.1 exp- 8	2100	
900	4.4 exp- 8	8410	
1000	1.4 exp- 7	26700	0

TEST BENCH
800 VEK

900 VOLTS MCP
INPUT PENETRATION (Vi) AL_2O_3

VOLTS	OUTPUT CURRENT	GAIN
100 E_k	4.2 X10- 9	
200	8.0 X10- 9	
300	1.45 X10- 8	
400	2.1 X10- 8	
500	2.9 X10- 8	
600	3.55 X10- 8	
700	4.1 X10- 8	
800	4.45 X10- 8	
900	4.7 X10- 8	
1000	4.8 X10- 8	

8%

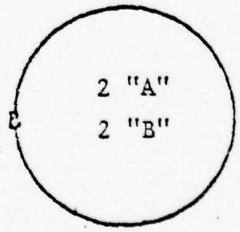
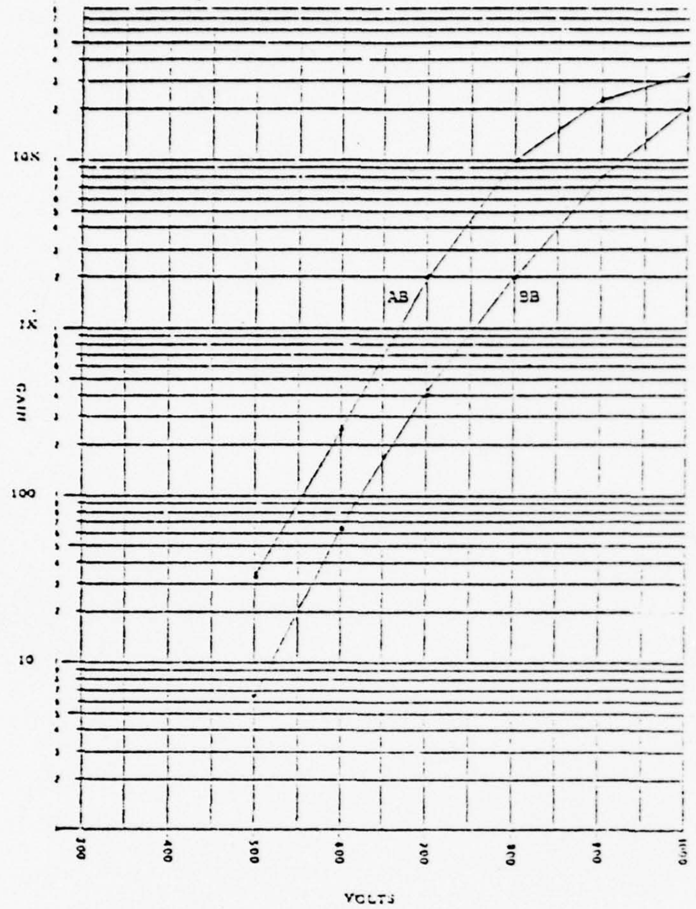


Figure 10. TEST DATA SHEET
MCP #542-30



MCP S/N 542-33
VENDOR IIT
DATE TESTED 3-1-77
DIA. 0.975 inches
THICKNESS 21.6 mils

	B.B.	A.B.	T.B.	
CONDUCTIVITY: @ 500V	0.9	0.9	0.9	μ amps
@1000V	2.0	2.05	2.0	μ amps

INPUT: 1.5 × 10^{-12} AMPS/CM^2

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD
500	2.0 exp-10	6.6	
600	1.9 exp-9	63	
700	1.2 exp-8	400	
800	6.0 exp-8	2000	
900	2.4 exp-7	8000	
1000	6.1 exp-7	20333	0

BEFORE BAKE 800 VEK

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD
500	1.0 exp-9	33	
600	8.0 exp-9	266	
700	6.0 exp-8	2000	
800	3.0 exp-7	10000	
900	7.0 exp-7	23333	
1000	1.0 exp-6	33333	0

AFTER BAKE 800 VEK

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD
500	2.8 exp-11	5.3	
600	2.4 exp-10	45	
700	1.5 exp-9	286	
800	7.6 exp-9	1453	
900	3.2 exp-8	6118	
1000	1.1 exp-7	21032	0

TEST BENCH 800 VEK

900 VOLTS MCP
INPUT PENETRATION (Vi) Al_2O_3

VOLTS	OUTPUT CURRENT	GAIN
100 E_k	2.7 x10-9	
200	5.2 x10-9	
300	9.1 x10-9	
400	1.5 x10-8	
500	2.1 x10-8	
600	2.5 x10-8	
700	3.0 x10-8	
800	3.2 x10-8	
900	3.4 x10-8	
1000	3.5 x10-8	

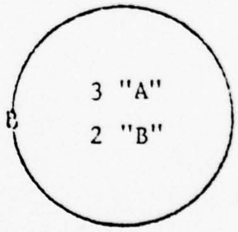
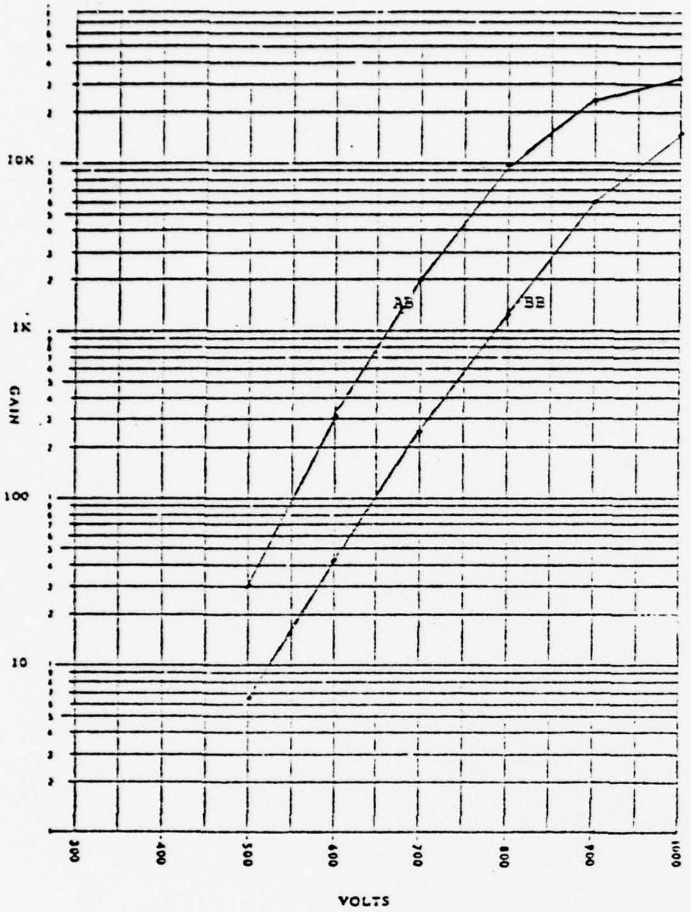


Figure 11. TEST DATA SHEET
MCP #542-33



MCP S/N 542-32
VENDOR ITT
DATE TESTED 2-25-77
DIA. 0.975 inches
THICKNESS 21.6 mils

CONDUCTIVITY:	B.B.	A.B.	T.B.	
@ 500V	0.92	1.0	0.9	μ amps
@1000V	2.0	2.15	2.0	μ amps

INPUT: 1.5×10^{-12} AMPS/CM^2

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD	
500	2.0 exp-10	6.6		
600	1.3 exp- 9	43		
700	8.0 exp- 9	266		BEFORE BAKE 800 VEK
800	3.9 exp- 8	1300		
900	1.5 exp- 7	5000		
1000	4.4 exp- 7	14666	0	

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD	
500	9.0 exp-10	30		
600	9.5 exp- 9	316		
700	6.0 exp- 8	2000		AFTER BAKE 800 VEK
800	2.9 exp- 7	9666		
900	7.1 exp- 7	23666		
1000	1.0 exp- 6	33333	0	

MCP

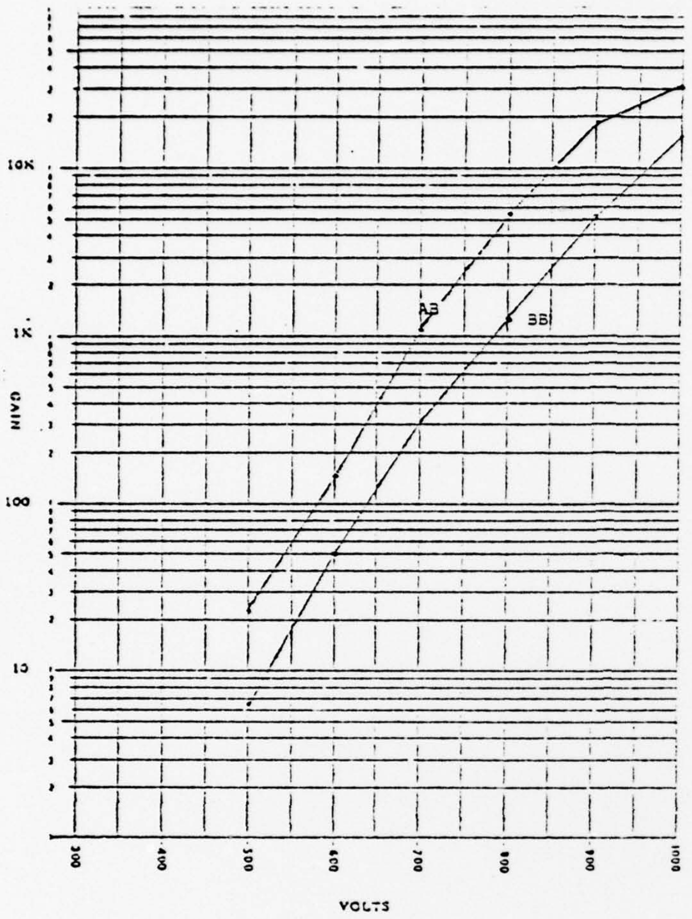
VOLTS	OUTPUT CURRENT	GAIN	BKGD.	
500	2.6 exp-11	5.0		
600	2.3 exp-10	44		
700	1.5 exp- 9	286		TEST BENCH 800 VEK
800	7.1 exp- 9	1357		
900	3.0 exp- 8	5730		
1000	1.0 exp- 7	19100	0	

900 VOLTS MCP
INPUT PENETRATION (Vi) Al_2O_3

VOLTS	OUTPUT CURRENT	GAIN	
100 E_k	2.8 X10- 9		
200	5.3 X10- 9		
300	9.3 X10- 9		
400	1.4 X10- 8		
500	2.0 X10- 8		
600	2.4 X10- 8		
700	2.7 X10- 8		
800	2.9 X10- 8		
900	3.0 X10- 8		7%
1000	3.1 X10- 8		

5 "A"
1 "B"

Figure 12. TEST DATA SHEET
MCP #542-32



MCP S/N 542-26

VENDOR ITT

DATE TESTED 2-23-77

DIA. 0.975 inches

THICKNESS 21.6 mils

CONDUCTIVITY:	B.B.	A.B.	T.B.	
@ 500V	1.5	1.55	1.3	μ amps
@1000V	3.2	3.3	2.8	μ amps

INPUT: 1.5×10^{-12} AMPS/CM^2

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD
500	2.0 exp- 10	6.6	
600	1.5 exp- 9	50	
700	9.3 exp- 9	310	
800	4.1 exp- 8	1366	
900	1.6 exp- 7	5333	
1000	5.1 exp- 7	17000	0

BEFORE BAKE

800 VEK

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD.
500	7.0 exp- 10	23	
600	4.8 exp- 9	160	
700	3.3 exp- 8	1100	
800	1.65 exp- 7	5500	
900	5.7 exp- 7	19000	
1000	9.5 exp- 7	31666	0

AFTER BAKE

800 VEK

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD.
500	1.1 exp- 10	21	
600	3.3 exp- 10	63	
700	1.8 exp- 9	344	
800	8.1 exp- 9	1550	
900	3.2 exp- 8	6110	
1000	9.0 exp- 8	17200	0

TEST BENCH

800 VEK

900 VOLTS MCP

INPUT PENETRATION (Vi) Al_2O_3

VOLTS	OUTPUT CURRENT	GAIN
100 E_k	2.8 X10-9	
200	5.1 X10-9	
300	8.7 X10-9	
400	1.4 X10-8	
500	2.0 X10-8	
600	2.5 X10-8	
700	2.9 X10-8	
800	3.15 X10-8	
900	3.33 X10-8	
1000	3.50 X10-8	

10%

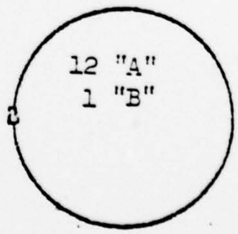
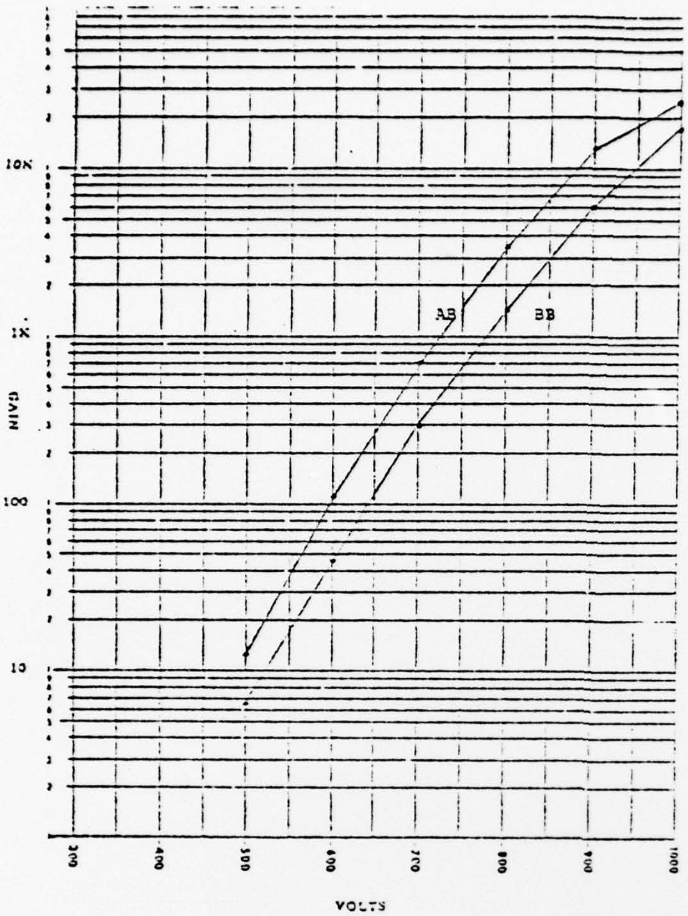


Figure 13. TEST DATA SHEET
MCP #542-26



MCP S/N 464-T1
VENDOR ITT
DATE TESTED 2-22-77
DIA. 0.975 inches
THICKNESS 21.8 mils

CONDUCTIVITY:	B.B.	A.B.	T.B.	
@ 500V	0.95	1.05	1.0	μ amps
@1000V	2.1	2.3	2.1	μ amps

INPUT: 1.5×10^{-12} AMPS/CM^2

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD
500	2.0 exp-10	6.7	
600	1.4 exp- 9	46	
700	9.0 exp- 9	300	
800	4.6 exp- 8	1533	
900	1.9 exp- 7	6333	
1000	5.6 exp- 7	18666	0

BEFORE BAKE
800 VEK

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD.
500	4.0 exp-10	13	
600	3.5 exp- 9	116	
700	2.2 exp- 8	733	
800	1.05 exp- 7	3500	
900	4.3 exp- 7	14333	
1000	7.8 exp- 7	26000	0

AFTER BAKE
800 VEK

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD.
500	1.7 exp-11	4.8	
600	1.55 exp-10	45	
700	1.05 exp- 9	298	
800	5.1 exp- 9	1448	
900	2.15 exp- 8	6107	
1000	7.0 exp- 8	19880	0

TEST BENCH
800 VEK

900 VOLTS MCP
INPUT PENETRATION (Vi) Al_2O_3

VOLTS	OUTPUT CURRENT	GAIN
100 E_k	2.4 X10-9	
200	4.4 X10-9	
300	7.2 X10-9	
400	1.1 X10-8	
500	1.5 X10-8	
600	1.8 X10-8	
700	2.0 X10-8	
800	2.2 X10-8	
900	2.3 X10-8	
1000	2.33 X10-8	

7.0%

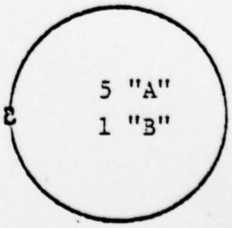
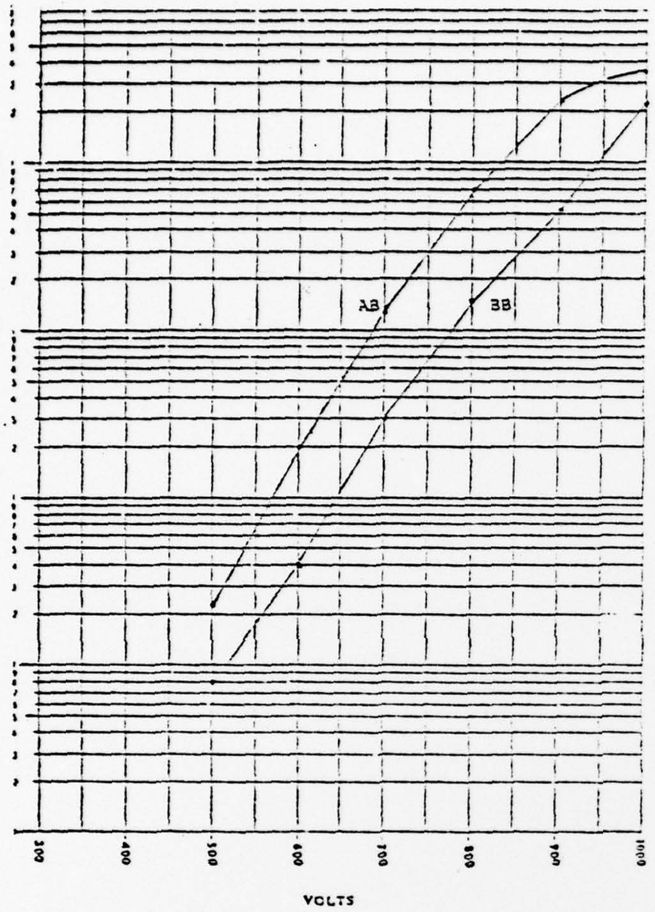


Figure 14. TEST DATA SHEET
MCP 464-T1



MCP S/N 464-T6

VENDOR ITT

DATE TESTED 2-15-77

DIA. 0.975 inches

THICKNESS 21.8 mils

CONDUCTIVITY:

	B.B.	A.B.	T.B.	
@ 500V	1.45	1.6	1.4	μ amps
@1000V	3.1	3.4	3.0	μ amps

INPUT: 1.5×10^{-12} AMPS/CM^2

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD
500	2.4 exp- 10	8.0	
600	1.2 exp- 9	40	
700	9.0 exp- 9	300	
800	5.0 exp- 8	1666	
900	1.6 exp- 7	5333	
1000	6.5 exp- 7	21666	0

BEFORE BAKE 800 VEK

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD.
500	7.0 exp- 10	23	
600	6.0 exp- 9	200	
700	4.1 exp- 8	1366	
800	2.1 exp- 7	7000	
900	7.1 exp- 7	23666	
1000	1.1 exp- 6	36660	0

AFTER BAKE 800 VEK

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD.
500	2.2 exp- 11	42	
600	1.9 exp- 10	36	
700	1.3 exp- 9	248	
800	6.4 exp- 9	1223	
900	2.7 exp- 8	5160	
1000	9.4 exp- 8	17970	0

TEST BENCH 800 VEK

900 VOLTS MCP
INPUT PENETRATION (Vi) Al$_2$O$_3$

VOLTS	OUTPUT CURRENT	GAIN
100 E$_k$	3.9 X10-9	
200	6.4 X10-9	
300	1.1 X10-9	
400	1.5 X10-8	
500	2.0 X10-8	
600	2.3 X10-8	
700	2.55X10-8	
800	2.7 X10-8	7.0%
900	2.8 X10-8	
1000	2.9 X10-8	

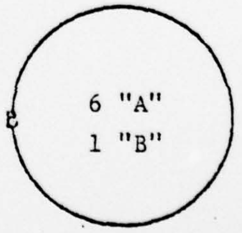


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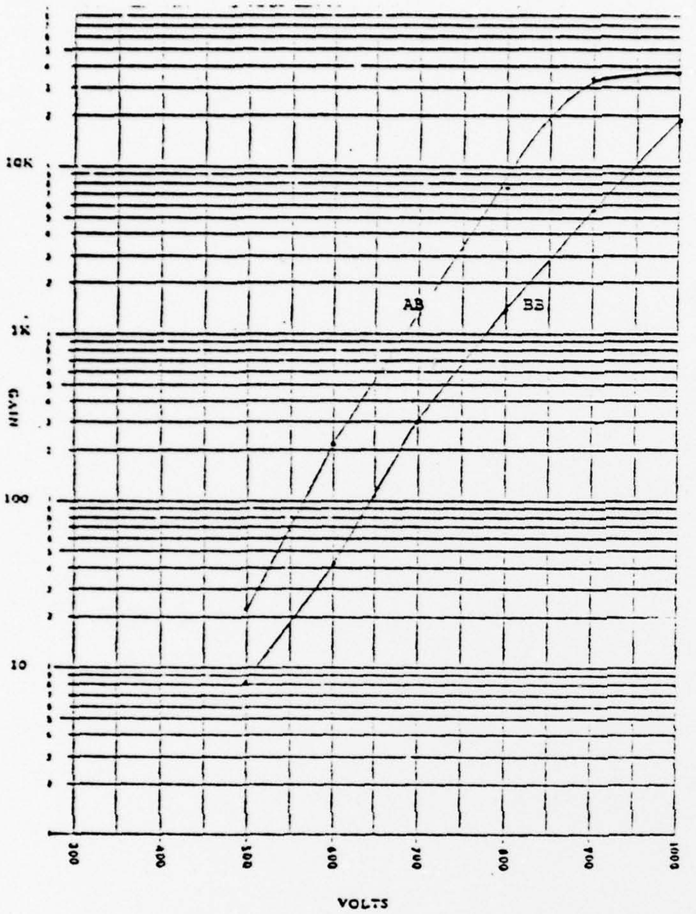
Figure 15. TEST DATA SHEET
MCP #464-T6



MCP S/N 464-TS
VENDOR ITT
DATE TESTED 2-16-77
DIA. 0.975 inches
THICKNESS 21.8 mils

CONDUCTIVITY:	B.B.	A.B.	T.B.	
@ 500V	1.2	1.3	1.15	μ amps
@ 1000V	2.7	2.85	2.4	μ amps

INPUT: 1.5×10^{-12} AMPS/CM^2

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD
500	2.5 exp-10	8.3	
600	1.3 exp- 9	43	
700	9.0 exp- 9	300	
800	4.4 exp- 8	1466	
900	1.7 exp- 7	5666	
1000	5.7 exp- 7	19000	0

BEFORE BAKE
800 VEK

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD
500	7.0 exp-10	23	
600	6.6 exp- 9	220	
700	4.4 exp- 8	1466	
800	2.33 exp- 7	7766	
900	7.4 exp- 7	34660	
1000	1.1 exp- 6	36666	0

AFTER BAKE
800 VEK

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD
500	3.6 exp-11	6.8	
600	3.3 exp-10	63	
700	2.2 exp- 9	420	
800	1.2 exp- 8	2290	
900	4.7 exp- 8	8980	
1000	1.5 exp- 7	28600	0

TEST BENCH
800 VEK

900 VOLTS MCP
INPUT PENETRATION (Vi) AL_2O_3

VOLTS	OUTPUT CURRENT	GAIN
100 E_k	4.5 X10- 9	
200	9.0 X10- 9	
300	1.6 X10- 8	
400	2.4 X10- 8	
500	3.2 X10- 8	
600	3.9 X10- 8	
700	4.4 X10- 8	
800	4.7 X10- 8	
900	5.0 X10- 8	
1000	5.1 X10- 8	

7.5%

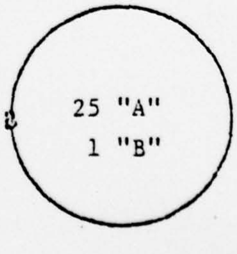
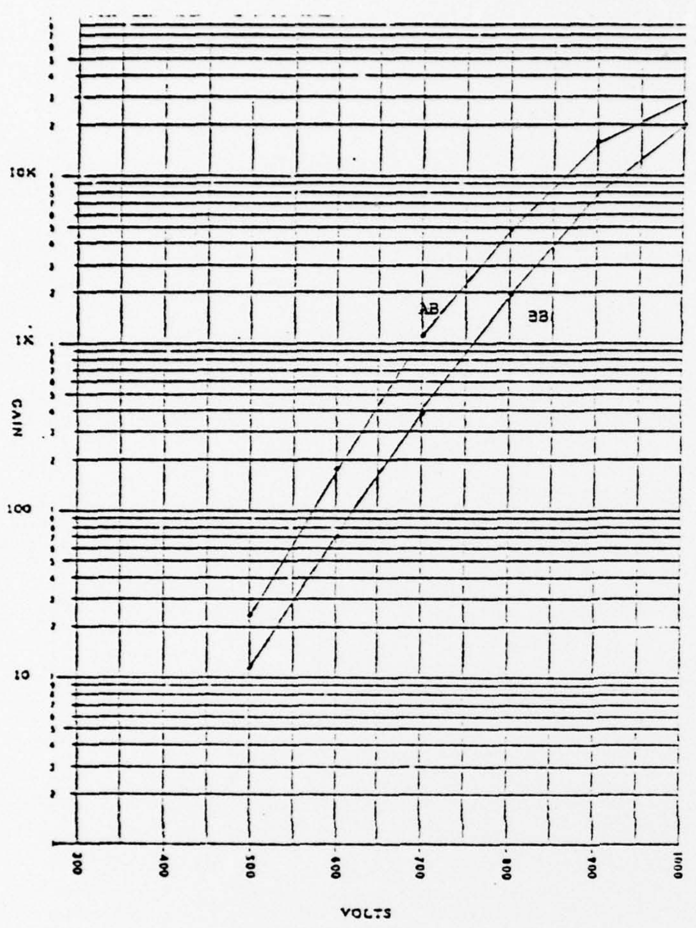


Figure 16. TEST DATA SHEET
MCP #464-TS



MCP S/N 542-19
VENDOR ITT
DATE TESTED 2-28-77
DIA. 0.975 inches
THICKNESS 21.6 mils

CONDUCTIVITY:	B.B.	A.B.	T.B.	
@ 500V	1.3	1.35	1.3	μ amps
@1000V	2.89	2.95	2.7	μ amps

INPUT: 1.5×10^{-12} AMPS/CM^2

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD
500	4.0 exp-10	12	
600	2.3 exp- 9	69	
700	1.3 exp- 8	390	
800	6.5 exp- 8	1969	
900	2.5 exp- 7	7575	
1000	6.6 exp- 7	20000	0

BEFORE BAKE
800 VEK

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD.
500	8.0 exp-10	24	
600	5.8 exp- 9	175	
700	3.7 exp- 8	1121	
800	1.6 exp- 7	4848	
900	5.7 exp- 7	17270	
1000	9.0 exp- 7	27272	0

AFTER BAKE
800 VEK

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD.
500	3.8 exp- 11	7.2	
600	3.2 exp- 10	61	
700	2.0 exp- 9	382	
800	9.3 exp- 9	1778	
900	3.7 exp- 8	7070	
1000	1.1 exp- 7	21000	0

TEST BENCH
800 VEK

900 VOLTS MCP
INPUT PENETRATION (Vi) Al_2O_3

VOLTS	OUTPUT CURRENT	GAIN
100 E_k	3.3×10^{-9}	
200	6.0×10^{-9}	
300	1.0×10^{-8}	
400	1.7×10^{-8}	
500	2.3×10^{-8}	
600	3.0×10^{-8}	
700	3.45×10^{-8}	
800	3.85×10^{-8}	
900	4.05×10^{-8}	
1000	4.2×10^{-8}	

10%

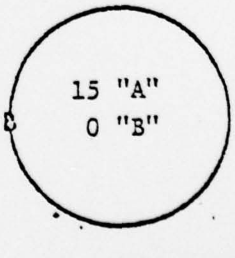


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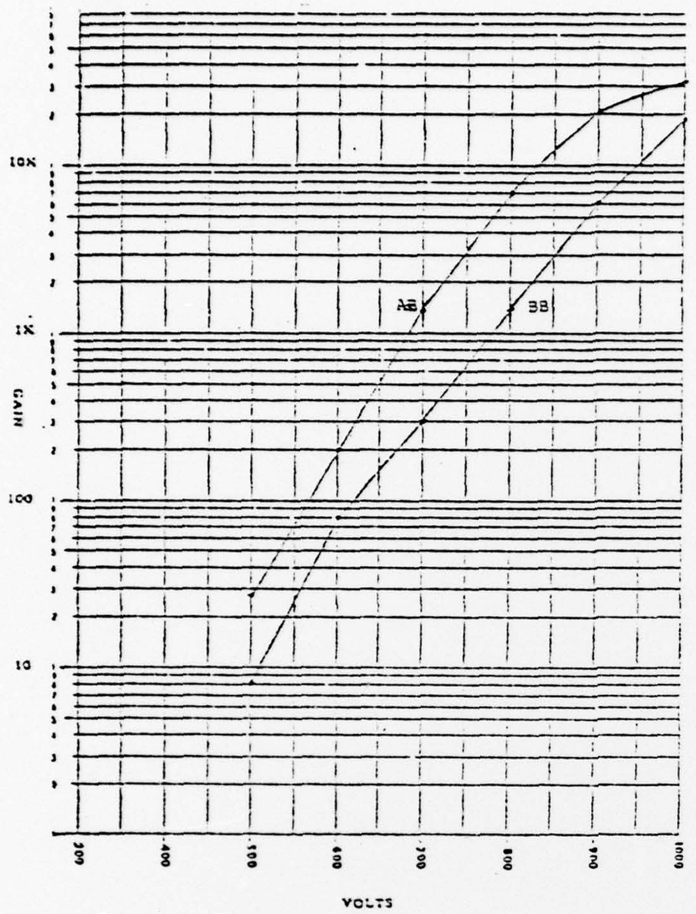
Figure 17. TEST DATA SHEET
MCP #542-19



MCP S/N 542-29

VENDOR ITT

DATE TESTED 3-3-77

DIA. 0.975 inches

THICKNESS 21.6 mils

CONDUCTIVITY:	B.B.	A.B.	T.B.	
@ 500V	1.15	1.2	1.2	μ amps
@1000V	2.53	2.65	2.4	μ amps

INPUT: 1.5×10^{-12} AMPS/CM^2

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD
500	2.5 exp-10	8.3	
600	2.4 exp- 9	80	
700	9.0 exp- 9	300	
800	4.7 exp- 8	1566	
900	1.9 exp- 7	6333	
1000	5.6 exp- 7	18666	0

BEFORE BAKE

800 VEK

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD.
500	8.5 exp-10	28	
600	6.0 exp- 9	200	
700	4.3 exp- 8	1433	
800	2.1 exp- 7	7000	
900	6.5 exp- 7	21666	
1000	9.5 exp- 7	31666	0

AFTER BAKE

800 VEK

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD.
500	6.8 exp-11	13	
600	5.9 exp-10	113	
700	3.7 exp- 9	707	
800	1.9 exp- 8	3630	
900	7.0 exp- 8	13400	
1000	2.1 exp- 7	40100	0

TEST BENCH

800 VEK

900 VOLTS MCP
INPUT PENETRATION (Vi) Al_2O_3

VOLTS	OUTPUT CURRENT	GAIN
100 E_k	6.5 X10-9	
200	1.3 X10-8	
300	2.3 X10-8	
400	3.6 X10-8	
500	5.2 X10-8	
600	6.5 X10-8	
700	7.6 X10-8	
800	8.4 X10-8	
900	8.9 X10-8	
1000	9.3 X10-8	

10%

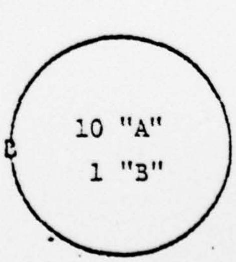
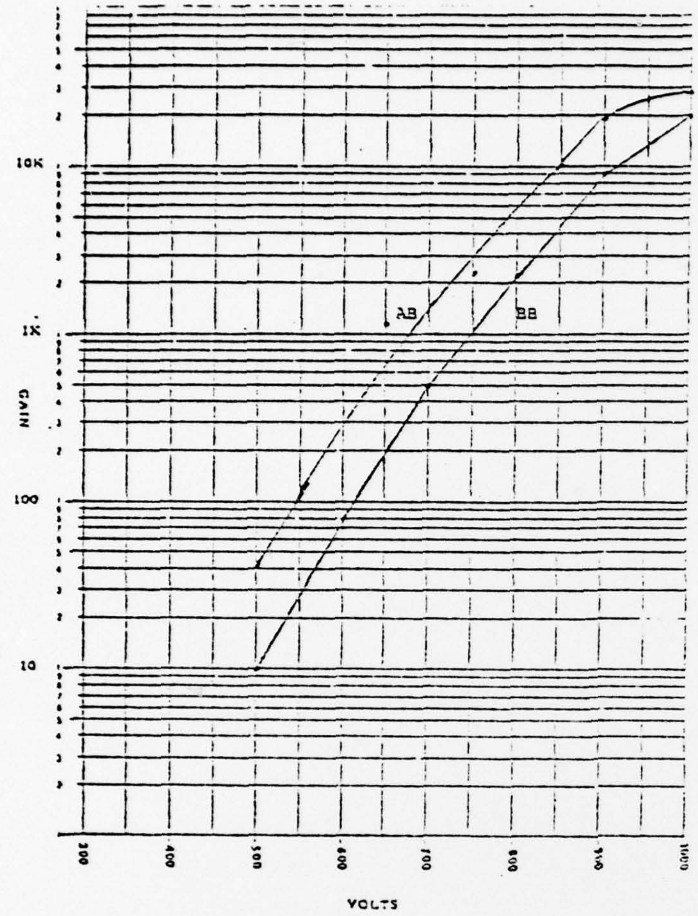


Figure 18. TEST DATA SHEET
MCP #542-29



MCP S/N 508-20
VENDOR ITT
DATE TESTED 2-17-77
DIA. 0.975 inches
THICKNESS 22.2 mils

CONDUCTIVITY:	B.B.	A.B.	T.B.	
@ 500V	0.9	0.9	10.9	μ amps
@1000V	1.95	2.05	2.8	μ amps

INPUT: 1.5×10^{-12} AMPS/CM^2

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD	
500	3.0 exp- 10	10		
600	2.4 exp- 9	80		
700	1.5 exp- 8	500		BEFORE BAKE
800	7.1 exp- 8	2366		
900	2.67 exp- 7	8900		900 VEK
1000	6.1 exp- 7	20333	0	

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD.	
500	1.3 exp- 9	43		
600	3.6 exp- 8	1200		
700	7.0 exp- 8	2333		AFTER BAKE
800	3.0 exp- 7	10000		
900	5.8 exp- 7	19330		900 VEK
1000	8.3 exp- 7	27666	0	

MCP

VOLTS	OUTPUT CURRENT	GAIN	BKGD.	
500	5.7 exp- 11	11		
600	5.0 exp- 10	96		
700	3.2 exp- 9	610		TEST BENCH
800	1.6 exp- 8	2050		
900	6.0 exp- 8	11500		900 VEK
1000	1.6 exp- 7	20500	0	

900 VOLTS MCP
INPUT PENETRATION (Vi) AL_2O_3

VOLTS	OUTPUT CURRENT	GAIN	
100 E_k	5.4 X10-9		
200	1.1 X10-8		
300	1.3 X10-8		
400	2.6 X10-8		
500	3.4 X10-8		
600	4.1 X10-8		
700	4.6 X10-8		
800	4.9 X10-8		)
900	5.12 X10-8		) 8%
1000	5.25 X10-8		)

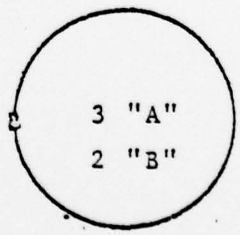


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Figure 19. TEST DATA SHEET
MCP #508-20

flood gun testing capability to simulate tube test conditions.

3.0 CONCLUSIONS (U)

(U) Careful picking and cleaning of MCP's prior to lacquering and the addition of an edge grind to remove polishing compound have resulted in a cleaner MCP and hence, in a reduction of type A and B holes. It was also established that the application of a thicker lacquer film further reduced the number of type A and B holes. Higher quality ion barrier films can now be produced at high yield by utilizing the oil-free Varian evaporator and a dual shutter system to precisely control deposition rate and film thickness.

(U) Smooth MCP surfaces have been achieved with the introduction of a prepolish technique which eliminates scratches. Because of difficulties encountered in reproducing uniform fire polished surfaces, the fire polish technique was discontinued in favor of the pre-polish technique.

(U) Evaluation of Al_2O_3 filmed MCP's in the demountable test head and in tubes, has indicated that film quality evaluation is strongly dependent on test technique employed. To increase test reliability and to achieve better correlation with evaluation in tubes, both the engineering demountable test head and the newly constructed bakeable and demountable system will be equipped with a flood gun arrangement.

4.0 SCHEDULE (U)

Effort planned for the next quarter include:

4.1 Complete debugging of Bakeable Demountable Test System. (U)

4.2 Fabricate and Test Five (5) Engineering Samples to Category III Requirements. (U)

4.3 Install Flood Gun Viewing Device for Al_2O_3 MCP Evaluation in both Demountable Systems. (U)

4.4 Continue investigation of defects and elimination of defects by using thick Al_2O_3 filmed MCP's. (U)

4.5 Complete MCP Surface Improvement by Utilizing Prepolish Technique. (U)

5.0 CONFERENCES AND REPORTS (U)

5.1 Conferences (U)

(U) Mr. John Rennie visited ITT EOPD on March 10th and 11th and reviewed progress to date and planning for 4th quarter.

5.2 Reports (U)

(U) The draft copy of the second quarterly report has been submitted. Monthly progress letters for January, February, and March have been submitted.

6.0 GLOSSARY (U)

Å - Angstrom

Al_2O_3 - Chemical abbreviation for aluminum oxide

Lacquer - An organic liquid which is applied to the MCP to temporarily cover the channel holes. After a smooth sheet of Al_2O_3 is evaporated on top of the lacquer, the lacquer is removed by baking in oxygen.

MCP - Microchannel plate

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