A184 766 ION PLATING: FUNDAMENTAL PROCESSING STUDIES AND SYNTHESIS OF HIGH PERFORM (U) ILLINOIS UNIV AT URBANA DEPT OF MATERIALS SCIENCE AND ENGINEE J M RIGSBEE 1/1

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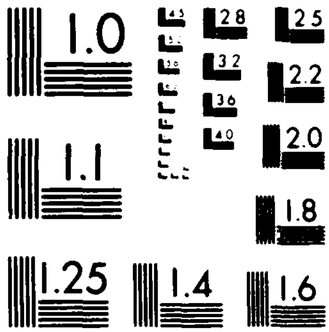
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REPORT DOCUMENTATION PAGE

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1a REPORT SECURITY CLASSIFICATION Unclassified	1b RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3 DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.
2b DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S) ARO 21067.6-MS
6a. NAME OF PERFORMING ORGANIZATION University of Illinois — 6b OFFICE SYMBOL (If applicable) Metallurgy	7a. NAME OF MONITORING ORGANIZATION U. S. Army Research Office
6c. ADDRESS (City, State, and ZIP Code) Dept. of Materials Science & Engineering 1304 West Green Street Urbana, Illinois 61801	7b. ADDRESS (City, State, and ZIP Code) P. O. Box 12211 Research Triangle Park, NC 27709-2211
8a. NAME OF FUNDING/SPONSORING ORGANIZATION U. S. Army Research Office — 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER DAAG29-83-K-0151
8c. ADDRESS (City, State, and ZIP Code) P. O. Box 12211 Research Triangle Park, NC 27709-2211	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO — PROJECT NO. — TASK NO. — WORK UNIT ACCESSION NO

11 TITLE (Include Security Classification) (unclassified) Ion Plating: Fundamental Processing Studies and Synthesis of High Performance Coatings

12 PERSONAL AUTHOR(S) J. M. Rigsbee

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final	FROM 11/83 TO 4/87	87/08/04	

16 SUPPLEMENTARY NOTATION The view, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

17 COSATI CODES		
FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
ion plating; plasma-assisted physical vapor deposition; nucleation; thin films; corrosion; wear; hard coatings

19 ABSTRACT (Continue on reverse if necessary and identify by block number)

Ion plating is a physical vapor deposition process which uses a plasma to modify the microstructure/microchemistry of thin film coatings. This research has directly shown that processing variables such as plasma energy/density; substrate temperature; deposition rate; and substrate surface chemistry directly effect the deposited film microstructure and chemistry. This processing technique allows mechanically strong/chemically graded interface layers to be produced between dissimilar materials. Film adhesion with this process is correspondingly excellent. This process was used to produce corrosion and wear resistant hard coatings.

In a related portion of this program, a model was developed to explain experimental observations for thin film nucleation mechanisms. The analytical expressions developed were able to closely model film nucleation and showed that preferential nucleation at defect sites and the dissociation of small clusters are controlling factors for thin film nucleation based on an island growth model.

20 DISTRIBUTION/AVAILABILITY OF ABSTRACT ☐ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21 ABSTRACT SECURITY CLASSIFICATION Unclassified
22a NAME OF RESPONSIBLE INDIVIDUAL	22b TELEPHONE (Include Area Code) — 22c. OFFICE SYMBOL

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete

SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

ION PLATING: FUNDAMENTAL PROCESSING STUDIES AND SYNTHESIS OF HIGH PREFORMANCE COATINGS

FINAL REPORT

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August 4, 1987

U. S. Army Research Office

DAAG29-83-K-0151

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FINAL REPORT

Statement of Problem

Ion plating is a physical vapor deposition process involving the deposition of a coating under continuous bombardment with low to medium energy ions. Coatings deposited by this process are recognized to have excellent physical properties and to be very useful under corrosion and wear conditions. In spite of the attractiveness of these coatings, little basic research has been done to understand how the many processing variables (e.g., ion energy and flux, substrate cleanliness and temperature, and deposition rate) affect the structure, chemistry and physical properties of these coatings. This was the major emphasis of this research program. This program also was concerned with obtaining a better understanding of thin film nucleation mechanisms. Primarily, the approach was to develop analytical expressions to model the effects of surface defects and small cluster dissociation on film nucleation via an island growth model. These expressions were compared with experimental data.

Summary of Results

This effort has yielded a much improved understanding of ion plated films and how processing variables influence the structure and chemistry of such films. Basically, the continuous ion bombardment during film growth promoted improved film density and adhesion. The film density is improved through conversion from a usual collumnar growth mode (for no ion bombardment and low growth temperatures) to an equiaxed growth mode. Film adhesion is improved through the development of a chemically graded interface between the coating and substrate (this allows reduction of residual stress and thermal expansion coefficient difference effects). These studies mainly studied metal/metal elemental systems.

Other experimental efforts centered about production of titanium nitride and mixed oxide coatings through reactive ion plating. This work was done cooperatively with the U.S. Army Corps of Engineers Construction Engineering Research Laboratory. These coatings have uses ranging from corrosion to EMI/EMP. This interactive work is continuing.

The thin film nucleation modeling work was extremely productive. Analytical expressions were developed whigh significantly improved the ability to predict experimental results. This work showed that the dissociation of small clusters is a large contibution to the nucleation process, in direct conflict with other theoretical studies but in good agreement with available experimental data. Also, substrate surface defect density was shown to be critical and ofter rate controlling. Experimental efforts in this area are continuing.

Participating Scientific Personnel

J. M. Rigsbee, Principal Investigator

Y. W. Lee, completed Ph.D. degree in February, 1986
continued as Post Doc on this project and in
association with USA-CERL

J. C. Logas, completed M.S. degree in May, 1987

H. S. Savage, completed M.S. requirements, degree to be
awarded in Fall 1987

D. M. Leet, completed M. S. degree in December, 1984

Degrees: Master of Science -- 3

Doctor of Philosophy -- 1

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