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AASERT93 REACTIVE ION SCATTERING AND DEPOSITION: THE ROLE OF MULTI-CHANNEL CHARGE TRANSFER

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13. ABSTRACT *(Maximum 200 words)*

Energetic ions or neutrals (in the hyperthermal energy range) have been used in a number of thin film growth applications (e.g., sputtering and plasma deposition techniques, direct ion beam and ion-assisted deposition, etc.). These involve both direct deposition of the film species with an ion beam, and depostion by some other method during simultaneous ion bombardment. Experiments and simulations have shown that energetic ions can lower the substrate temperature required to achieve crystallinity, can change growth morphologies, and influence structue and crystallographic orientation in the film. In many cases, the mechanisms responsible for ion-induced modification of growth are not understood at the atomic level. We have initiated both scattering and scanning tunneling microscopy (STM) studies to probe these mechanisms.

14. SUBJECT TERMS

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UNCLASSIFIED
AASERT ANNUAL TECHNICAL REPORT

GRANT: F49620-93-1-0504
PARENT AWARD: AFOSR-91-0137
PRINCIPLE INVESTIGATOR: Barbara H Cooper, Cornell University, Ithaca, NY

PROJECT TITLE: ION SCATTERING AND DEPOSITION: THE ROLE OF ENERGETIC PARTICLES IN THIN FILM GROWTH

The original AASERT award was entitled "Reactive Ion Scattering and Deposition: The Role of Multi-Channel Charge Transfer;" the student named to work on this project was Eric Dahl. Dahl subsequently received an AT&T Fellowship. A change in personnel was requested and approved: full time graduate student James McLean is supported by the AASERT grant. The new project title listed in the heading reflects this change in personnel; both Mclean and Dahl are working on projects that are part of our overall research effort to study the use of energetic ions in thin film growth. McLean is a US citizen whose performance (including grades) toward the PhD is satisfactory

PROGRESS

Energetic ions or neutrals (in the hyperthermal energy range) have been used in a number of thin film growth applications (e.g., sputtering and plasma deposition techniques, direct ion beam and ion-assisted deposition, etc.). These involve both direct deposition of the film species with an ion beam, and deposition by some other method during simultaneous ion bombardment. Experiments and simulations have shown that energetic ions can lower the substrate temperature required to achieve crystallinity, can change growth morphologies, and influence structure and crystallographic orientation in the film. In many cases, the mechanisms responsible for ion-induced modification of growth are not understood at the atomic level. We have initiated both scattering and scanning tunneling microscopy (STM) studies to probe these mechanisms.

McLean is working on STM studies to directly monitor the effects of ion bombardment on film morphology. His progress toward this goal is outlined briefly below.

Instrumentation: McLean has completed the installation of our STM in a UHV chamber equipped with sample cleaning and annealing capabilities, a residual gas analyzer, an Auger electron spectrometer, and gas dosing and deposition capabilities. Two ion guns mounted on the chamber are used for irradiating the sample after which *in-situ* STM measurements of the irradiated surface can be made (see below). The sample temperature can be varied during or after the irradiation both above and below room temperature. STM images are always taken at room temperature.

Preliminary results: McLean has begun STM measurements on surfaces of Au(111) irradiated with noble gas ion beams. Noble gas ions are used in ion-assisted growth. Since they are nonreactive we can assess how surface morphology evolves solely due to the ion collisions. The ion irradiation results in the formation of islands and pits. The observed islands and pits have characteristic size distributions that we will compare to theory (see below). We have also used time-lapse imaging to monitor the stability of the islands and pits. Experiments are in progress to monitor the evolution of surface morphology as a function of ion beam energy, ion dose, sample temperture during irradiation, etc.

McLean, in collabortion with theorists Badri Krishnamachari, Gerard Barkema and Jim Sethna, is developing a Monte Carlo code for simulating the formation and stability of surface islands and pits. These simulations will be used to form a microscopic understanding of macroscopic theories already applied to these processes.

Future: Future experiments will include a wide variety of reactive ion species and substrate materials. In these cases, in addition to collisional effects, chemical effects will play an important role in film formation. Growth conditions will be varied to mimic those typically used in direct ion beam deposition and ion-assisted deposition

AASERT Evaluation Report

a. Parent Award
AFOSR-91-0137   1/1/91-6/30/94

b. Amount of funding in the12 months prior to AASERT award-9/1/92-8/31/93

$93,796

FTE grad students in the12 months prior to AASERT award-9/1/92-8/83/93

2 FTE Graduate Students
1 FTE Graduate Student(summer 1993 only)

c. Amount of funding in the12 months after AASERT award-9/1/93-8/31/94

$71,140

FTE grad students in the12 months after AASERT award-9/1/93-8/31/94

1 FTE Graduate Student
1 Postdoctoral Associate
1 Visiting Scientist

d. AASERT Award
F49620-93-1-0504   9/1/93-8/31/97

Amount of funding during the 12 months after AASERT award date-9/1/93-8/31/94

$37,588

FTE grad & undergrad. students in 12 months after AASERT award-9/1/93-8/31/94

1 FTE Graduate Student
No Undergraduate students

e. Student is a United States Citizen.