ONR-1

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~~Progress Report~~ Final Report

N00014-91-1483

3/1/91 through 12/20/91

Calvin W. Lowe, PI

N00014-91-J-1483

This project "Ionized Assisted Deposition of Organic Films for Optoelectronic Applications" has as the first year prime objective to deposit 2-methyl-4-nitroaniline (MNA) films on glass substrates. The experimental apparatus was operational with the exception of a suitable substrate holder and integration of the time of flight mass spectrometer into the system. The principal investigator has decided to leave Hampton University as of 12/20/91 to become chairman of the physics department at Alabama A&M University (AAMU) in Huntsville, AL effective 1/2/92. We will propose to reestablish this project to AAMU.

This project has involved three graduate students; two of whom have supported by this grant. Mr. Gregory Wilson (African-American male) has been working on a computer model for the deposition beam as it leaves the crucible, passes through the ionization cell of the mass spectrometer and impinges on the substrate. He is working closely with Dr. William Marable, a plasma physicist in the math department. Mr. Wilson plans to complete this work for his MS degree under the primary direction of Prof. Marable.

Mr. Kang-il Seo (Korean male) has been responsible for the design of the substrate holder and crucible temperature controller and has deposited some MNA films. Mr. Seo has transferred to Alabama A&M University where he will pursue the Ph.D. and continue to work with the PI. Ms. Trina Veals (African-American female) is not supported by this grant but has been involved with installing and testing the time of flight mass spectrometer. She is currently searching for a new thesis project.

In the 10 months of this project, we have designed and installed a liquid nitrogen cooled substrate holder and shutter. The time of flight mass spectrometer is complete and needs only to be calibrated. This is a straightforward process involving admitting a known gas such as Ar into the system and noting the time delay for its mass peak on the oscilloscope.

The mass a function of time delay, t, is given by $m = kt$ where $k=\sqrt{2qV/L^2}$ with q the charge on the molecule, V the extraction pulse height, and L the length of the flight tube. Note that k is constant for all similarly charged molecules and may therefore be determined from one known mass such as Ar.

We have also noted several disadvantages of our current system as we have grown the first MNA films. These are detailed below with suggestions for changes in the system which may alleviate some of the problems we encountered.

First, cryopumping the system yields inadequate vacuum levels of about 10^{-5} torr with the source on. This seems to be due to the relative long distance (~ 20") between the main pumping port and the source chamber. We also propose to place a larger pump on the source section of the vacuum chamber.

Second, it proved impossible to deposit 2-methyl-4-nitroaniline (MNA) films onto room temperature substrates. Cooling the substrates to 77 K resulted in thick, powdery films at our operating pressure. This problem can be addressed by including a liquid nitrogen/resistive heater combination on the substrate holder. An Omega Engineering CN 2041 profile controller can maintain the substrate between -200 °C and 1300 °C with 1 °C stability.

Third, the small volume of the growth chamber was mainly occupied by the ionization cell of the time of flight mass spectrometer. This left little room to include film diagnostics. Not even a simple quartz balance to monitor film thickness could be use. We have asked the maker of the time of flight system (Comstock, Inc.) to design a significantly smaller ionization cell. Using the new cell, a low profile thickness monitor and an in-situ ellipsometer could be included.

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Statement A per telecon Dr. Alvin Goodman
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NWW 3/18/92