

# REPORT DOCUMENTATION PAGE

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13. ABSTRACT (Maximum 200 words)  Electron beam lithography equipment, sputtering unit and missing components of an MOCVD system have been ordered: LEO-440 electron microscope was outfitted with Nabyty Pattern Generation Systems software and associated hardware which allowed the microscope to be used in imaging and e-beam pattern generation modes. The instruments achieved 2 nm resolution in imaging mode and we are aiming at 50 nm in the writing mode. Necessary hardware components and operating software for a custom designed MOCVD system were ordered from EMCORE, received and integrated with the gas delivery system received from EMCORE and custom deposition reactor received from SVT Assoc. earlier. The system integration is nearly complete with some minor outstanding components from EMCORE. A sputtering system with one RF magnetron sputter gun and a pulsed magnetron sputter gun in an 18" chamber has been ordered from Kurt Lesker Company and is slated for delivery in a few months.				
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**FINAL DURIP TECHNICAL REPORT**  
Grant No. F49620-98-1-0356, U.S. Air Force  
Grant No. N00014-98-1-0291, Office of Naval Research

**Equipment Acquired:**

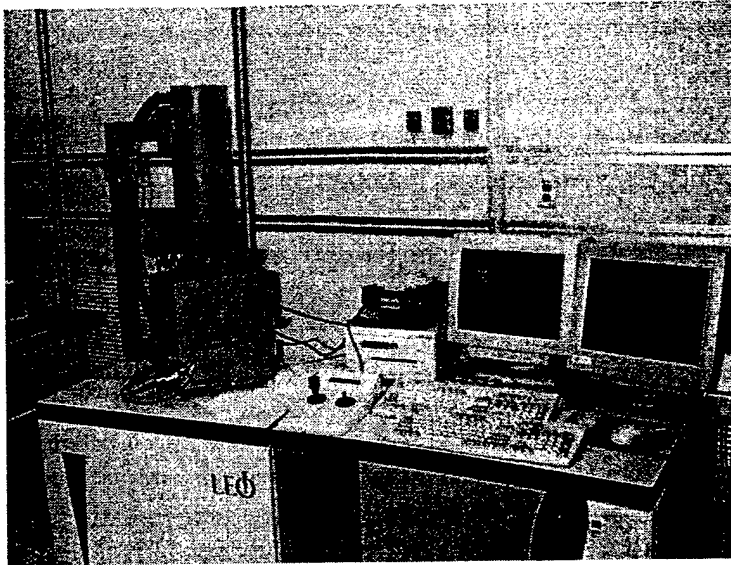
Scanning Electron Microscope & E-Beam Pattern Generation System  
MOCVD System  
Metallization System

Manufacturers included Leo-SEM, J. Naby, Emcore-SVT, Kurt Lesker

Total Costs: \$476,948; \$175,268 (ONR); \$201,680 (AF); \$100,000 (VCU)

The equipment funds provided under the above referenced grants have been put to use very effectively. As promised, a scanning electron microscope designed for electron beam writing has been received and installed. The funds originally slated for a contact mask aligner has been redirected, with approval from the funding agency, toward components needed for the custom designed MOCVD system. Those components have been received and installed. The metallization chamber is on order and will be delivered in a month or so.

E-beam pattern generation system: The e beam writer is composed of a LEO 440 microscope and NPGS: Naby Pattern Generation Systems, software and associated hardware. The system is equipped with LaB6 filament capability and rapid beam blanking option. The LaB6 filament will provide the resolution, stability and longevity we need. The software and the hardware are able to monitor the beam current going through the sample and adjust it to specified current levels so that large area patterns can be written at high currents. This system in its entirety has been received and installed. All the bugs with respect to imaging have been taken care of and system is now reliably operational. We are now in the process of conducting e beam writing experiments. The system is capable of producing 50 or less nanometer features. This combined with processing tricks that are available should get the feature sizes well below the 50 nm range. Below is a photograph of the installed system in our clean room.



Metallization system: The metallization system purchase considered the optimal use of the funds in the light of what we have available already. At the time the proposal was written, we did not know what if any metallization system we would be able to bring from our previous laboratory. Since we were able to bring our evaporation system with us, we decided to purchase a sputtering system. Below are the specifications for this system which were met by Kurt Lesker company with some 30 discount. This system will add much needed ability to deposit refractory metals and dielectrics which are used in many of the devices we investigate.

Proposals will be entertained for a sputtering system to be used for depositing dielectrics and to a lesser extent metals on 2 inch samples. There is no need for sample heating and cooling, but the uniformity is of importance. The detailed specs are as follows:

The Vacuum chamber is to be UHV compatible and made of stainless steel. The size desired is 15 to 18". The chamber is to be pumped by a turbomolecular pump/backing pump or a cryopump with a desired base pressure of  $5 \times 10^{-8}$  Torr or better. It should be fully gate valved and gauged and equipped with view ports. Shuttered ones would be preferred to avoid deposition on them. The pressure control capability, and precision gas inlet capability to sources are required. Rotating substrate holder facing the sources at a proper angle for uniformity, at 20 rpm or better. Substrate bias capability is needed, Sample size is 3", though 2" capability may be acceptable.

A UHV stainless steel load lock with sample transfer mechanism. Independent pumping, similar in nature to the deposition chamber, is required. It should be fully gate valved, with in vacuum transfer mechanism and easy sample loading and unloading capability. One sample at a time is fine.

Roughing lines for both the main chamber and the load lock should be gauged.

Two magnetron sputtering sources, 2" target diameter and compatible with the vacuum specifications. The operation pressure should be specified. It is desired that magnetron sources include a modular magnet array, integral gas injection and shutter capability.

Either two RF sources for the sputtering sources or one RF and one pulsed DC supply to power the magnetron sources.

Mask aligner (MOCVD Components): The funds initially slated for a contact mask aligner were redirected to purchasing the missing components for the MOCVD system. This was deemed necessary and was a smart move in addition. At the time of proposal submission we did not know if we could bring our mask aligner from our previous laboratory. Since we were able to bring our Karl Suss mask aligner and we needed funds to purchase additional components for the MOCVD system which are imperative, we made the optimal decision, with the concurrence of the funding agency, to purchase those components instead. The components include, hydrogen purifier, power supply for the substrate heater, substrate rotation and temperature controller, Ebara blower pump, liquid coolers, and various MKS components for sensing and controlling the chamber pressure. The deposition system, gas manifold, and all the aforementioned components have been integrated and necessary supply gas connections such as hydrogen, nitrogen, purified nitrogen, dry compressed air, ammonia, silane and other necessary lines have been assembled. We are currently working on the remaining wiring for computer control of all the components and outgassing the lines. Below is a picture of the MOCVD system with its gas panel and the custom deposition chamber. See a photograph of the system below.

