

To: Dr. Harold Guard

From: Wayne L. Gladfelter

Re: Final Report to ONR for supporting the following symposium

Grant number: N00014-95-0144

Chemical Perspectives of Microelectronic Materials

Fall Meeting of the Materials Research Society

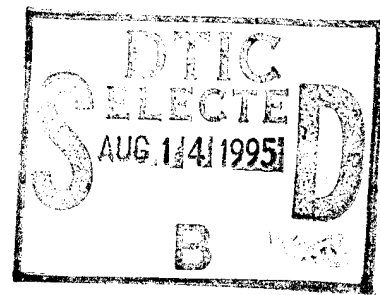
Boston, MA

November 27 - December 2, 1994

Symposium Organizers: Vincent Donnelly, Steve Gates, Jennifer Zinck, and
Wayne Gladfelter

Total oral presentations: 93 (16 invited lectures)

Total poster presentations: 77



Synopsis

Symposium E opened with presentations spanning a range of new directions in the Chemistry of Electronic Materials. Novel methods for patterning or deposition of materials and for IN SITU monitoring of materials processing were highlighted. Very fine dimensional control over growth using focussed laser beams, controlled use of surface chemistry, and photochemistry were all demonstrated. Several commercial applications of monolayer control of film growth and uniformity using atomic layer epitaxy were reported. IN SITU probing of surface species and topography during film growth using IR spectroscopy, and TEM and AFM microscopies revealed new details of growth mechanisms. Despite decades of work in Si chemistry, this area continues to thrive. Polycarbosilanes and polysilanes are attracting new

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interest as all-dry-processing resist materials.

Several developments in copper CVD were described at the meeting. These have improved the reliability of the process, especially when using $\text{Cu}(\text{hfac})(\text{tmvs})$ where hfac = hexafluoroacetylacetonato and tmvs = trimethylvinylsilane. Use of the direct liquid injection method has allowed more complicated CVD precursor "formulations" that improve the stability of the precursor during storage (accomplished by adding excess tmvs) and the smoothness of the final Cu films (accomplished by adding $\text{Hhfac}\cdot 2\text{H}_2\text{O}$). Further developments in the deposition of gold, aluminum, tungsten, and titanium nitride rounded out the well-attended session on metallization.

Among the more promising alternatives to silane and germane for the deposition of silicon and germanium are the alkylsilanes and germanes. Studies of the surface chemistry of Et_2SiH_2 , Et_2GeH_2 , and $t\text{-BuSiH}_3$ agreed that cleavage of the C-E bond is facile but disagreed regarding the details of the mechanism. New routes to main group and transition metal tellurides utilized two somewhat different procedures. Thin film and bulk samples of bismuth and antimony telluride (Bi_2Te_3 and Sb_2Te_3) were prepared by reacting bis(trimethylsilyl)tellurium with the tris(dimethylamido)stibane and bismuthane complexes. Transition metal systems such as NiTe were readily synthesized using zerovalent metal complexes and PR_3Te . In several cases novel cluster intermediates were isolated. Finally, new single source precursors were reported for the growth of thin films of ZnS, GaN, SiC, and transition metal gallides.

In one of the most exciting sessions of the conference, the latest developments in preparing and isolating nanocrystalline CdSe were described. Using careful precipitation techniques, Bawendi and coworkers were able to drastically reduce the polydispersity of the nanocrystals. The

narrow size distribution allowed the detailed assignment of the optical transitions within the of the clusters and allowed the nanocrystals to pack in well-ordered two and three dimensional arrays. A somewhat different approach produced the fascinating molecular crystal containing individual cluster units of $\text{Cd}_{17}\text{S}_4(\text{SR})_{26}$. The cluster units were connected into a three dimensional ZnS-like network through bridging SR ligands.

Si etching in halogen-containing plasmas remains an area of active research. Low-pressure plasmas with high charge-densities and low ion energies have emerged as the optimum conditions for the fine-line etching required today. Several experimental and theoretical papers dealt with this topic. Experimental observations and model predictions are beginning to converge, although there is still much that is not understood about this system. Low-energy electron enhanced etching with a hydrogen plasma was also reported, and shows some promise as low-damage technique.

A special joint session with Symposium II, Materials for Smart Systems, focussed on the rapidly expanding area of chemical sensors. Choice of the appropriate chemically selective interface materials was shown to be key in the implementation of surface acoustic wave devices, transducers with thin film sensing elements, which can be sensitive to, for example, 0.5% of a monolayer of carbon atoms. A novel sensor approach for the detection of semiconductor process gases such as ammonia, phosphine, and arsine utilized the change in photoluminescence intensity resulting from the modification of surface band structure following adsorption of these gases on a CdSe substrate. A common theme in this session was the necessity to understand the materials chemistry associated with sensor response. For example, the sensitivity of a CO and hydrocarbon sensor based on the Cu-Mn-O system was critically dependent on the film morphology, composition

and doping.

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