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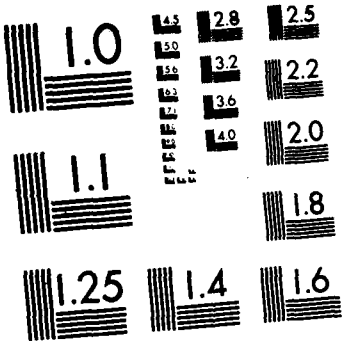

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Final Report

Laser-Assisted Chemical Reactions of Organometallic Complexes at Surfaces

by

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February 1988

SUMMARY

Objectives

The objectives of this research program are to investigate laser-assisted chemical reactions involving organometallic complexes for deposition of electronic materials at low temperatures. Specific areas of investigation are to (1) elucidate the kinetics and mechanisms of the photophysical and photochemical processes operative during laser-stimulated dissociation of organometallic complexes and subsequent reaction of the photoproducts with a surface, (2) apply studies of photo-induced processes to the deposition of semiconductors, such as GaAs, AlAs, and [Ga,Al]As, and conductors such as Au, and (3) establish experimental conditions under which epitaxial growth of the deposited materials can be achieved.

Accomplishments

We have synthesized several new organometallic complexes for use in the investigation of laser-assisted depositions on this program. Complexes containing Ga-As and Al-As bonds have been used in the first photochemical deposition of stoichiometric films of GaAs and [GaAl]As. These studies have demonstrated that laser irradiation parallel to the substrate produces stoichiometric films and that with irradiation perpendicular to the substrate a competition exists between desorption and photodeposition, which adversely affects the stoichiometry of the film.

Using an excimer laser operating at 308 nm (XeCl) we have deposited pure gold films using the volatile gold-containing complex dimethylgold hexafluoroacetoacetonate. Deposition rates up to 20 μm/hr on silicon, germanium, GaAs, quartz, and sapphire substrates have been observed with the substrates held at room temperature. Surface analysis (XPS) of these films has shown them to be free of any contaminants from the ligands or other sources. To our knowledge this is the first report of the deposition of high quality pure gold films by a low temperature photochemical process.

Additionally, we have developed and applied laser-induced fluorescence and multiphoton ionization spectroscopy for real-time, non-intrusive detection of gas-phase intermediates and products generated during beam-assisted chemical reactions. These results have enabled us to detect Si, Ga, As, and Te atoms generated by photodissociation of organometallic source materials. These studies have provided us with important information about the photochemistry and dissociation dynamics of organometallic compounds used as source materials for the photochemical deposition of semiconductors.

PRESENTATIONS, PUBLICATIONS AND PATENTS

Presentations

1. "Excimer Laser-Induced Reactions of Thin Solid Films of Gallium-Arsenic Molecular Complexes" J.E. Jensen and G.L. Olson, Mater. Res. Soc., Boston, MA (Dec. 1984).

2. "Laser-Assisted Deposition of Metals and Semiconductors" L.W. Tutt and J.E. Jensen, Southern California Photochemistry Conference, Lake Arrowhead, CA (June 1986).

3. "Excimer Laser-Assisted Deposition of GaAs, AlAs, and [Al,Ga]As on Ge<100> Surfaces From Donor-Acceptor Complexes" J.J. Zinck, P.D. Brewer, J.E. Jensen, G.L. Olson, and L.W. Tutt, Mater. Res. Soc., Boston, MA (Dec. 1986).

4. "Two-Photon Laser-Induced Fluorescence and '2+1' Multiphoton Ionization of Silicon Atoms" P.D. Brewer, Conf. on Lasers and Electroopt., Baltimore, MD (Apr. 1987).

5. "Alkyl Telluride UV Photodissociation Dynamics" P.D. Brewer, J.J. Zinck, J.E. Jensen, L.W. Tutt, and G.L. Olson, Mater. Res. Soc., Boston, MA (Dec. 1987).

Publications

1. J.J. Zinck, P.D. Brewer, J.E. Jensen, G.L. Olson, and L.W. Tutt, Mater. Res. Soc. Symp. Proc. **75**, 233 (1987).

2. P.D. Brewer, Chem. Phys. Lett. **136**, 557 (1987)

3. P.D. Brewer, Chem. Phys. Lett. **141**, 301 (1987)

4. J.J. Zinck, P.D. Brewer, J.E. Jensen, G.L. Olson, and L.W. Tutt, Appl. Phys. Lett., submitted.

5. P.D. Brewer, J.E. Jensen, G.L. Olson, L.W. Tutt, and J.J. Zinck, (Alkyl Telluride UV Photodissociation Dynamics) 1988, submitted to Mater. Res. Soc. Symp. Proc.

6. L.W. Tutt, W.J. Gignac, and J.E. Jensen, (The Excimer Laser-Assisted Deposition of Gold From Dimethylgold Hexafluoroacetoacetonate) 1988, in preparation.

7. L.W. Tutt and J.E. Jensen, (Mechanism of the Photodissociation of Dimethylgold Hexafluoroacetoacetonate) 1988, in preparation.

Patents

1. Method For Forming Gallium Arsenide From Thin Solid Films of Gallium-Arsenic Complexes, filed 20 November 1984; issued 10 June 1986, patent #4,594,264.

2. Low Temperature Photochemical Deposition of High Purity Gold Films, invention disclosure filed 15 December 1987, application in preparation.

PERSONNEL

The following Hughes Research Laboratories personnel contributed to the research program:

Peter D. Brewer
John E. Jensen
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Lee W. Tutt
Jenna J. Zinck

END

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