Debra J. Lightly Mascaro

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Education

MASSACHUSETTS INSTITUTE OF TECHNOLOGY — Cambridge, MA
Ph.D. in Materials Science and Engineering, *June 2004*
Field of Study: Electronic, Photonic and Magnetic Materials
IBM Research Fellow, 1999-2000
National Science Foundation Graduate Fellow, 1996-1999

GUSTAVUS ADOLPHUS COLLEGE — Saint Peter, MN
B.A. in Physics, Summa Cum Laude, *May 1995*
Barry M. Goldwater Scholar, 1993-1995
National Merit Scholar, 1991-1995

Research Experience

UNIVERSITY OF UTAH — Salt Lake City, UT
Research Assistant Professor, Department of Mechanical Engineering — *January 2005-present*

NDSU CENTER FOR NANOSCALE SCIENCE AND ENGINEERING — Fargo, ND
Research Scientist — *January-December 2004*

- Sensor development and microfabrication related to microsensor systems. Miniaturization of chemiresistive sensors used for the detection of explosives and chemical warfare agents.
- Characterization of novel polymeric materials for spintronics device applications.

MIT LAB OF ORGANIC OPTICS AND ELECTRONICS — Cambridge, MA
Graduate Research Assistant — *1997-2004*
Thesis on "Formation of In-Plane Crystals of Molecular Organic Semiconductors" under Professor V. Bulović, Department of Electrical Engineering, and Professor T. M. Swager, Department of Chemistry

- Developed methods for generating ordered films of crystalline organic materials over large area substrates with the aim of using the films in practical device applications. Introduced solvent vapor annealing as a means to facilitate the formation of oriented crystalline needles from amorphous organic films grown on nano-patterned substrates.
- Developed large area nano-structures that enabled: (1) the demonstration of organic photonic band gap thin films, presently being used to improve outcoupling from organic LEDs and to develop organic super-prisms, waveguides, and optical filters, and (2) the deposition of nano-structured polymer monolayers by soft lithography and nano-scale molding/embossing of organic thin film structures.
- Investigated analyte-activated photoconductivity as a potential sensing mechanism for TNT and other explosives.
- Explored ways to electrochemically embed conducting polymers within hydrogels in order to transduce mechanical swelling into an electrical signal.

IBM T. J. WATSON RESEARCH CENTER — Yorktown Heights, NY
Research Intern, Physical Sciences Department — *Summer 2000, Summer 1999*

- Investigated the effects of various substrate treatments on the morphology and device performance of pentacene field-effect transistors.
- Fabricated and characterized the electrical properties of polymer and small molecule organic field-effect transistors.

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UNIVERSITY OF MINNESOTA HORMEL INSTITUTE Austin, MN
Senior Laboratory Technician, Biophysics Group *1995-1996*
- Isolated and purified pancreatic proteins for intestinal lipolysis studies.

GUSTAVUS ADOLPHUS COLLEGE Saint Peter, MN
Undergraduate Research Assistant, Physics Department *1994-1995, Summer 1992*
- Characterized polymer films by scanning tunneling microscopy.
- Measured the optical energy gaps of silicon-tellurium glasses.

GENERAL ATOMICS San Diego, CA
National Undergraduate Fellowship in Plasma Physics & Fusion Engineering *Summer 1994*
- Analyzed data to compare plasma fluid rotation and plasma mode rotation in the DIII-D tokamak.

ARIZONA STATE UNIVERSITY Tempe, AZ
NSF Research Experience for Undergraduates *Summer 1993*
- Investigated the two-dimensional lattice structure of cystosine molecules adsorbed on gold by electrochemical scanning tunneling microscopy.

Research Support

Funding Agency: NATIONAL SCIENCE FOUNDATION
Funding Period: September 15, 2004 to August 31, 2006
Role in Project: Principal Investigator (Co-PIs: V. Bulović, MIT; I. Akhatov, NDSU)
Title: *Direct In-plane Formation of Large Organic Crystals for Active Nanostructured Devices*
Abstract: The objective of this research is to combine expertise in materials science, fluid dynamics, and electrical engineering to (1) implement a new method for growth of millimeter-scale organic crystals directly on a large-area substrate and (2) utilize the crystals in active nanostructured optoelectronics. The approach uses a single-step process in which amorphous organic thin films crystallize during room temperature exposure to solvent vapor. Preliminary investigations led to the discovery of elongated in-plane crystals that are more than 100 times larger than any previously reported, spanning the length of an entire substrate (up to 1 cm long). Achieving the targeted goals of this program would for the first time allow integration of organic crystals with existing optoelectronic devices and in such a way enable the development of entirely new technologies. The proposed theoretical modeling will facilitate rational extension of the crystal growth technique to a broad range of organic materials, enabling fundamental investigations of their electronic, optical and structural properties.

Publications

Mascaro, D. J., Thompson, M. E., Smith, H. I., and Bulović, V., "Forming Oriented Alq_3 Crystals from Amorphous Thin Films on Patterned Substrates via Solvent-Vapor Annealing," submitted for publication in *Chemistry of Materials*, 2004.

Dimitrakopoulos, C. D. and Mascaro, D. J., "Organic Thin-Film Transistors: A Review of Recent Advances," *IBM Journal of Research and Development*, Vol. 45, 2001, pp. 11-27.

Kosbar, L. L., Dimitrakopoulos, C. D., Mascaro, D. J., "The Effect of Surface Preparation on the Structure and Electrical Transport in an Organic Semiconductor," in *2001 Materials Research Society Spring Meeting Proceedings,* San Francisco, CA, 2001, C10.16.

Lightly, D. J., "Scanning Tunneling Microscopy of Cytosine," *Journal of Undergraduate Research in Physics,* Vol. 12, 1993, pp. 47-50.

Presentations

Mascaro, D. J., Zartman, J. J., Smith, H. I., and Bulović, V., "Forming Oriented Organic Crystal Needles by Solvent-Vapor Annealing of Amorphous Thin Films on Nano-Patterned Substrates," presented at the Materials Research Society Spring Meeting, April 2003, San Francisco, CA.

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Mascaro, D. J., Swager, T. M., Smith, H. I., and Bulović, V., "Guided Growth of Organic Films on Nano-Patterned Substrates," presented at the Materials Research Society Spring Meeting, April 2002, San Francisco, CA.

Lightly, D. J., Enoki, T., Tanaka, T., and Swager, T. M., "Polyaniline/NIPA Gel Composite Device for Sensor Applications," presented at the Materials Research Society Fall Meeting, December 1998, Boston, MA.

Technical Skills

- Extensive experience in the use of materials surface and bulk diagnostic techniques including atomic force microscopy (AFM), scanning electron microscopy (SEM), transmission electron microscopy (TEM), scanning tunneling microscopy (STM), and x-ray diffraction (XRD).
- Hands-on experience with all the steps involved in fabrication of active organic devices including material purification (via thermal gradient sublimation), lithographic substrate processing, vacuum system operation, device encapsulation, and device testing.
- Design and maintenance of an integrated materials growth system consisting of a series of high vacuum chambers connected to a controlled atmosphere glove box.
- Experience in many areas of microfabrication including contact lithography, interferometric lithography, thermal oxidation, plasma-enhanced chemical vapor deposition (PECVD), e-beam evaporation, and reactive ion etching (RIE).
- Hardware and software interfaces for lab equipment using LabVIEW and Visual Basic.

Leadership Experience

Officer, Green Hall *1996-2000*
Chaired the hall judicial committee. Managed the hall budget and funds. Organized social events. Proposed and oversaw the conversion of a storage room to a study lounge.

Vice-President, Departmental Graduate Student Committee *1997-1998*
Organized orientation activities for new graduate students. Assisted with visitation weekends for prospective graduate students. Coordinated departmental course reviews.