ANDREW SARANGAN

ASSOCIATE PROFESSOR OF ELECTRO-OPTICS

Vision, innovation

behind UD's electro-optics program

With a cache of scholarly literature, an ambition for scientific advancement and a new nanophotonics fabrication laboratory he built "from scratch" in 2004, UD electro-optics associate professor Andrew Sarangan can take his ideas from concept to experiment — and sometimes to market — all in one place.

"It is wonderful," he says. "I have the flexibility to try out new things free from short-term market pressures."

With support from the state of Ohio, industrial partners and the Air Force Research Laboratory at Wright-Patterson Air Force Base, he and his master's and doctoral students are finding new methods of using photons — tiny light particles — to make microscale and nanoscale components for telecommunications and infrared applications for commercial, military, safety and security purposes.

"Optics is a key driving force behind new technologies in telecommunications, medicine and manufacturing," says Sarangan, who earned his bachelor's, master's and doctoral degrees in electrical and computer engineering at the University of Waterloo in Ontario, Canada. He came to UD in 2000.

"Electro-optics is at the interface between electrical engineering and physics," Sarangan says. "It's a fairly new and unique discipline that only a handful of schools have. UD is one of those schools that offers master's and doctoral degrees in electro-optics. Our laboratory facilities allow us to think of new ideas and turn them to reality usually on the same day. Our students get hands-on exposure to state-of-the-art technology and tools, which is becoming a rarity these days."

In the nanophotonics fabrication lab, built with grants of $200,000 from UD and $2 million from the Ohio Third Frontier Project to promote innovation and build Ohio's world-class research capacity, Sarangan and his students can deposit "thin films" of dielectrics and metals as thin as 10 nanometers — 10 billionths of a meter — for use in optical and electronic components. A plasma reactor etches silicon for making microscopic optical components. Another machine deposits glass films using a chemical vapor process. Another piece of equipment writes precision patterns on a silicon wafer with nanometer-scale resolution. Sarangan, his students and researchers can use these tools to develop new components with the accuracy, positioning and repeatability necessary for quality, reliability and efficiency.

"We are one of the few institutions with such a comprehensive facility," he says. "We are developing techniques to work with fairly ordinary materials to develop optical components that can, for example, improve the quality of images from an infrared camera and the speed of optical communication equipment."

Silicon is the most commonly used material today for its low cost and its technological maturity, Sarangan says, but he and his cohort are finding new materials for nanoscale lenses and mirrors that can work with much greater precision. Photonic crystals, he explains, can boost a device's bandwidth — its data transmission rate, usually measured in gigabits per second — by improving the performance of the lasers, detectors and modulators.

"This will improve the quality for applications such as border patrols, search and rescue, and military applications," Sarangan says.

L3 Communications of Cincinnati, an industry leader in the production and sales of infrared cameras, has taken several UD innovations to market already.

"My main focus is to develop technology that could ▶

be commercialized," Sarangan says. "As engineers, our goal is to discover economical solutions to complex technical problems. As such, industry adoption is the ultimate measure of our success."

Sarangan has several U.S. patents, among which are a method of making nonplanar micro-optical structures and a multi-wavelength gain-coupled distributed feedback laser array with fine tunability. He has published in a variety of noted journals, including the Institute of Electrical and Electronics Engineers' *Journal of Quantum Electronics and Optics Express,* the International Electronic Journal of Optics. In four years, he has received more than $2.1 million in external funding for research on which he was the principal investigator.

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and visualization through full-field methods. Presented at the 15th U.S. National Congress on Theoretical and Applied Mechanics, Boulder, CO.

Kanchanavally, S., **Ordóñez, R.**, & Schumacher, C. J. (2006). Path planning in three dimensional environment using feedback linearization. Presented at the American Control Conference, Minneapolis, MN.

Kang, H., & **Altman, A.** (2006). An empirical method for the prediction of stagnation point location on airfoils. Presented at the 31st Dayton-Cincinnati Aerospace Sciences Symposium, Dayton, OH.

Kissock, K., & Eger, C. (2006). Measuring plant-wide industrial energy savings. Presented at the Society of Automotive Engineers World Congress and Exposition, Detroit, MI.

Lafdi, K. (2006). Nonocomposites: Opportunities and challenges. Presented at the ENSAM Workshops Chalons en Champagne, France.

Larsen, J. M., **John, R.**, Jha, S., Caton, M., Rosenberger, A. H., **Brockman, R. A.**, et al. (2006). Life prediction and durability of high-temperature materials. Presented at the AFOSR Structural Mechanics Meeting, Seattle WA.

Li, L., & **Lafdi, K.** (2006). Growth of carbon nanotubes on carbon artifacts. Presented at the Intern. Carbon Conference, Ohio Nanosummit, Columbus, OH.

Malhas, F. (2006). Steel design using the AISC 2005 provisions. Presented at the Fourth Jordanian Conference.

Malhas, F. (2006). Steel design using the AISC 2005 provisions. Presented at the Structural Engineering Association of Ohio Annual Meeting.

McCarty, R., Monaghan, D., **Hallinan, K.**, & **Sanders, B.** (2006). Experimental verification of source temperature modulation via a thermal switch in thermoelectric energy harvesting. Presented at the ASME IMECE, Chicago, IL.

Mozumder, Z., **Haus, J. W.**, & **Zhan, Q.** (2006). Modulation instability for a cylindrically polarized beam. Presented at the Great Lakes Photonics Symposium, Dayton OH.

Mozumder, Z., Katte, N., **Haus, J. W.**, & **Zhan, Q.** (2006). Topological charge effects on azimuthal modulation instabilities for cylindrical polarization in nonlinear media. Presented at the Frontier of Optics, Rochester, NY.

Myers, K. J., Janz, E. E., & Fasano, J. B. (2006). Characterization of the gas dispersion capabilities of the BT-6 impeller. Presented at the 2006 AIChE Annual Conference, San Francisco, CA.

Sanders, B., McCarty, R., Ahlers, K., & **Hallinan, K. P.** (2006). Structurally integrated thermal energy harvesting subsystems. Presented at the NATO RTO Specialist Meeting of Multifunctional Structures, Vilnius, Lithuania.

Shaik, R., **Ordóñez, R.**, & Ramachandran, R. P. (2006). Nonylphenol biodegradation kinetics estimation using neural networks. Presented at ISCAS.

Shaikh, S., & **Lafdi, K.** (2006). Effect of nanotube additives on the latent energy storage of phase change materials. Presented at the Ohio Nanosummit, Columbus, OH.

Shaikh, S., & **Lafdi, K.** (2006). Thermal conductivity improvement in carbon nanoparticle doped PAO-oil. An experimental and theoretical study. Presented at the Dayton Engineering Science Symposium, Dayton, OH.

Subramanyam, G. (2006). Novel test structure for microwave characterization of dielectric thin-films. Presented at the SPIE Great Lakes Photonics Symposium.

Subramanyam, G. (2006). Recent advances in voltage tunable microwave dielectrics. Presented at the IEEE International Microwave Symposium, Bangalore, India.

Subramanyam, G. (2006). Test structure for characterization of ferroelectric thin-films. Presented at the SPIE Great Lakes Photonics Symposium, Dayton, OH.

Whitney, J. M. (2006). Interlaminar shear relations for composite beams. Presented at the American Sociiety for Composites 21st Technical Conference, Dearborn, MI.

Whitney, J. M., & **Brockman, R. A.** (2006). Free edge stresses in unsymmetric bidirectional laminates subjected to axial load. Presented at the American Society for Composites 21st Technical Conference, Dearborn, MI.

Yao, J., **Ordóñez, R.**, & Gazi, V. (2006). Swarm tracking using artificial potentials and sliding mode control. Presented at the 45th IEEE Conference on Decision and Control, San Diego, CA.

Zhan, Q., & Powers, P. (2006). Tera-Hertz polarization devices. Presented at the Great Lakes Photonics Symposium, Dayton OH.

Zhang, C., & **Ordóñez, R.** (2006). Extremum seeking control based on numerical optimization and state regulation -- Part I: Theory and framework. Presented at the 45th IEEE Conference on Decision and Control, San Diego, CA.

Zhang, C., & **Ordóñez, R.** (2006). Extremum seeking control based on numerical optimization and state regulation -- Part II: Robust and adaptive control design. Presented at the 45th IEEE Conference on Decision and Control, San Diego, CA.

Zhang, C., & **Ordóñez, R.** (2006). Non-gradient extremum seeking control of feedback linearizable systems with application to ABS design. Presented at the 45th IEEE Conference on Decision and Control, San Diego, CA.

INVITED LECTURES/SEMINARS

Chase, D. (2006). Floodplain analysis using HEC-RAS. *Continuing education workshop*, Fuller, Mossbarger, Scott & May Engineers.

Chase, D. (2006). Low impact development. *Educational seminar*, Dayton, OH.

Chase, D. (2006). Low impact development. *Educational seminar*, Dayton, OH.

Eylon, D. (2006). Light metals for the German aerospace industry. *Workshop*, Dresden Airport Seminar, Germany.

Eylon, D. (2006). Light metals for the German research faculty. *Workshop*, Clausthal Technical University.