

# René López

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## EXPERIENCE

### VANDERBILT UNIVERSITY

***Research Assistant Professor November 2004-present***

***Postdoctoral Associate, June 2002 – November 2004***

*Nanofabrication and advanced light-nanoparticle interaction studies.*

The light interaction with matter is in the core of my scientific interest. In particular, my concentration is on multifunctional nanoparticles that can significantly interact with electromagnetic fields. I have been studying the optical response of ordered arrays of nanoparticles (vanadates and also noble metals) in which the dependence of the plasmon resonance on the inter-particle distance is the key issue. I have developed novel protocols for fabrication of the first VO<sub>2</sub> nanocrystal arrays, as well as techniques to study them. I have discovered ultrafast IR optical nonlinearities in VO<sub>2</sub> nanocrystals by z-scan techniques and I have also established a time limit of 70 fs for the laser induction of the semiconductor-to-metal phase transition with a pump-probe configuration. I have revealed that the light scattered from ordered VO<sub>2</sub> nanoarrays presents unique features, specifically size-dependent photonic resonances and optical switching in the visible range with a convoluted and reversible order-disorder transition. My work covers all the steps from fabrication to physical modeling of the aforementioned systems, as well as guiding graduate students and teaching a fundamental physics class (spring 2006).

### OAK RIGE NATIONAL LABORATORY (ORNL)

***Research assistant, February 2000 – April 2002***

Condensed Matter Division (Dr. Lynn A. Boatner and Dr. Tony E. Haynes)

*Effects of size on the semiconductor-to-metal phase transition and on the optical properties of VO<sub>2</sub>*

By means of ion implantation and thermal processing, I was able to produce controlled-sized nanoscale VO<sub>2</sub> precipitates embedded in SiO<sub>2</sub> and make the first observation of a size effect in the VO<sub>2</sub> phase transition. I discovered that the optical behavior shown by the particles in the SiO<sub>2</sub> matrix was the result of a surface plasmon resonance. This was the first observation of this effect in this material. Beside these contributions to material and physical sciences, the practical possibilities of this novel composite material led to experiments with my collaborators to produce different configurations and to tailor the properties. For example, we controlled the width of the hysteresis loop by adding Ti ions before precipitation. We also proved that W lowers the VO<sub>2</sub> phase transition temperature to below room temperature. The ion implantation technique proved to be an easy and convenient way to incorporate VO<sub>2</sub> nanoparticles into optical fibers and thin film Si/SiO<sub>2</sub> technologies.

### VANDERBILT UNIVERSITY

***Research Assistant, July 1999 – January 2000***

Applied Optics (Prof. Richard F. Haglund) and Solid State (Prof. Leonard C. Feldman) groups

My first research project was the fabrication of a transparent conductor comprising alternating layers of silver and aluminum oxide. The goal of the project was to apply etalon optical resonances to overcome the metallic absorption in the visible range and at the same time, retain high electrical conductivities of the metal. Transmittances of 0.7 over specific wavelength bands were achieved with resistivities as low as 6E-6 Ω\*cm, almost two orders of magnitude

lower than that of the best transparent conductors, such as indium tin oxide. All properties were modeled using my computer codes.

**MATSUSHITA ELECTRIC COMPANY (PANASONIC), Tijuana, Mexico**

***Control Engineer, January 1997- March 1997***

Project leader for an effort to apply statistical control methods to optimize quality in a production line.

**LABORATORY FOR THE DEVELOPMENT OF ELECTRONIC INDUSTRIES, LIDIME, Monterrey, Mexico.**

***Project Engineer, August 1995 – January 1997***

Failure analysis of semiconductor fabrication processes.

## EDUCATION

**VANDERBILT UNIVERSITY, Nashville, TN.**

**PhD in Physics**, August 1998 – May 2002. GPA: 3.96/4.0

Dissertation: Metal semiconductor phase transition in VO<sub>2</sub> nanocrystals. Advisors: Prof. Richard F. Haglund Jr. and Prof. Leonard C. Feldman.

Thesis: Metal Semiconductor Phase Transition in VO<sub>2</sub> nanocrystals

**VANDERBILT UNIVERSITY, Nashville, TN.**

**MS in Physics**, August 1998 – May 2000

Project: Pulsed laser deposition of metallo-dielectric thin films.

**CENTER OF INVESTIGATION AND ADVANCED STUDIES (CINVESTAV)**

**Partial credit- MS in sciences**, Mexico City. April 1997 – July 1998. GPA: 4.0/4.0

Partial credit transferred to Vanderbilt University.

**MONTERREY INSTITUTE OF TECHNOLOGY AND SUPERIOR STUDIES (ITESM)**

**BS in Industrial Physics and Engineering**, Monterrey, MEX, August 1992-December 1996. GPA: 98/100

Minors in Electrical Engineering, Optics and Robotics.

## AWARDS

- Winner of the ORNL Wigner Fellowship 2006
- Outstanding Student Research, presentation in Washington, DOE nanomeeting 2002.
- Southern University Association Scholarship to perform summer work at ORNL, 2000
- 1st Place, best grade average, Monterrey Institute of Technology, class 1996
- Monterrey's Institute of Technology, Excellency Scholarship award
- 1st Place academic Performance, ITESM High school Campus Chiapas, class 1993
- 3rd Place National Mathematical Olympics (Mexico), 1992
- 1st Place Chiapas Mathematical Olympics, 1992

## SKILLS

***Laboratory***

- Expertise in Pulsed Laser Deposition (PLD)
- Ion Implantation techniques
- Atomic Force Microscopy (AFM)
- Scanning Electron Microscopy (SEM)

- Ellipsometry
- Van der Pauw and Capacitance-Voltage
- Rutherford Backscattering spectroscopy
- *Some* Transmission Electron Microscopy
- Focused Ion beam (FIB)
- Polymer lithography
- Raman spectroscopy
- Ultrafast laser probed processes
- Nonlinear optical measurements
- Near Field Optical microscopy
- X-Ray Diffraction (XRD)

### ***Computational and Mathematical***

- Programming in Pascal and Fortran
- Mathematica®
- Unix, Windows and Mac Operating Systems
- Labview integration of experimental systems

### ***Languages***

- Spanish (native)
- English(99%)

## RESEARCH INTERESTS

- Thin film science
- Nanotechnology, nano-optics
- Ultrashort laser/matter interaction
- Nonlinear optics
- Optical/optical switching
- Photonic crystals

## PUBLICATIONS

### REFERED ARTICLES

- J. Y. Suh, E. U. Donev, **R. Lopez**, L. C. Feldman and R. F. Haglund, Jr., *Modulated optical transmission through subwavelength metal-VO<sub>2</sub> hole arrays*, **Appl. Phys. Lett.** **88**, 133115-1/133115-3 (2006). Also selected for the April 10, 2006 issue of Virtual Journal of Nanoscale Science & Technology. <http://www.vjnano.org>
- E. U. Donev, J. Y. Suh, F. Villegas, **R. Lopez**, L. C. Feldman, and R. F. Haglund Jr., "Optical properties of subwavelength hole arrays in vanadium dioxide thin films, **Phys. Rev. B rapid communications** **73**, 201401-1/201401-4 (2006). Also selected for the June 5, 2006 issue of Virtual Journal of Nanoscale Science & Technology. <http://www.vjnano.org>
- M. D. McMahon, **R. Lopez**, R. F. Haglund, Jr. *Second-Harmonic Generation from Arrays of Symmetric Gold Nanoparticles*, **Phys. Rev. B rapid communications** **73**, 041401(R)/1-041401(R)/4 (2006). Also selected for the January 23, 2006 issue of Virtual Journal of Nanoscale Science & Technology. <http://www.vjnano.org>
- J. Rozen, **R. Lopez**, L. C. Feldman, R. F. Haglund, Current percolation in nanocrystalline vanadium dioxide thin films, **Appl. Phys. Lett.** **88**, 081902-1/081902-3 (2006)
- M. D. McMahon, **R. Lopez**, H. M. Meyer III, L. C. Feldman, R. F. Haglund, Jr. *Rapid Tarnishing of Silver Nanoparticles in Ambient Laboratory Air*, **Applied Physics B** **80**, 915-921 (2005)
- M. Rini, A. Cavalleri, **R. Lopez**, L. A. Boatner, R. F. Haglund jr. T. E. Haynes, L. C. Feldman, R. W. Schoenlein. *Photoinduced Phase transition in VO<sub>2</sub> Nanocrystals: Ultrafast Control of the Surface Plasmon Resonance*, **Optics Letters** **30**, 558-561 (2005)

- **R. Lopez**, L. C. Feldman, R. F. Haglund, Jr. *Size dependent optical properties of VO<sub>2</sub> nanoparticles in ordered arrays.* **Phys. Rev. Lett.** **29**, 177403-1/ 177403-4 (2004). Also selected for the Issue 18. V. 10 of the *Virtual Journal of Nanoscale Science and Technology.* <http://www.vjnano.org>
- **R. Lopez**, R. F. Haglund, Jr., L. C. Feldman, T. E. Haynes, L. A. Boatner, *Optical nonlinearities in VO<sub>2</sub> nanoparticles and thin films,* **Appl. Phys. Lett.** **85**, 5191-5193 (2004). Also selected for the January 2005 Issue of the *Virtual Journal of Ultrafast Science.* <http://www.vjultrafast.org>
- **R. Lopez**, T. E. Haynes, L. A. Boatner, L. C. Feldman and R. F. Haglund Jr. *Switchable reflectivity on Silicon from composite VO<sub>2</sub>-SiO<sub>2</sub> protecting layer.* **Appl. Phys. Lett.** **85**, 1410-1412 (2004)
- J. Y. Suh, **R. Lopez**, L. C. Feldman, R. F. Haglund, Jr. *Semiconductor to metal phase transition in the nucleation and growth of VO<sub>2</sub> nanoparticles and thin films,* **J. Appl. Phys.** **96**, 1209-1213 (2004).
- L. C. Feldman, G. Lupke, N. H. Tolk, **R. Lopez**, R. F. Haglund Jr., T. E. Haynes, L. A. Boatner, *Particle-solid interactions and 21st century materials science.* **Nucl. Inst. and Met. Phys. Research B.** **212**, 1-7 (2003).
- **R. Lopez**, L. A. Boatner, T. E. Haynes, L. C. Feldman and R. F. Haglund Jr., *Synthesis and characterization of size-controlled vanadium dioxide nanocrystal in a fused silica matrix.* **J. Appl. Phys.** **92**, 4031-4036 (2002).
- **R. Lopez**, T. E. Haynes, L. A. Boatner, L. C. Feldman and R. F. Haglund Jr., *Temperature-controlled surface plasmon resonance in VO<sub>2</sub> nanorods.* **Optics Lett.** **27**, 1327-1330 (2002).
- **R. Lopez**, T. E. Haynes, L. A. Boatner, L. C. Feldman and R. F. Haglund Jr., *Size effects in the structural phase transition of VO<sub>2</sub> nanoparticles.* **Phys. Rev. B.** **65**, 224113-1/224113-5 (2002).
- **R. Lopez**, R. Ruiz, R.F. Haglund Jr., L.C. Feldman, *Pulsed laser deposition of conductive metallo-dielectric optical filters.* **Appl. Phys. A** **74**, 307-310 (2002).
- **R. Lopez**, L. A. Boatner, T. E. Haynes, R. F. Haglund Jr. and L. C. Feldman, *Enhanced hysteresis in the semiconductor-to-metal phase transition of VO<sub>2</sub> precipitates formed in SiO<sub>2</sub> by ion implantation.* **Appl. Phys. Lett.** **79**, 3161-3163 (2001).

#### REFERED ARTICLES IN PROCEEDINGS

- **Rene Lopez**, Richard F. Haglund, Jr., Leonard C. Feldman, Lynn A. Boatner, and Tony E. Haynes *Optical nonlinearities and the ultrafast phase transition of VO<sub>2</sub> nanoparticles and thin films.* Proceedings SPIE **Vol. 6118**, 61180O-1/61180O-8 (2006)
- Matthew D. McMahon, Christopher T. Bowie, **René Lopez**, Leonard C. Feldman, and Richard F. Haglund Jr. *Second harmonic generation from centrosymmetric arrays of gold nanoparticles.* Proceedings SPIE **Vol. 6106**, 61061N-1/61061N-6 (2006)
- **R. Lopez**, L. C. Feldman, R. F. Haglund, Jr. *Fabricating arrays of vanadium dioxide nanodisks by FIB lithography and PLD* **Proceedings of SPIE - The International Society for Optical Engineering - Photon Processing in Microelectronics and Photonics III**, **5339**, 601-610 (2004).
- M. Rini, A. Cavalleri, **R. Lopez**, L. A. Boatner, R. F. Haglund jr. T. E. Haynes, L. C. Feldman, R. W. Schoenlein. *Photoinduced Ultrafast control of a surface plasmon resonance via the insulator to metal phase transition in VO<sub>2</sub> nanoparticles.* **Proceedings of 14<sup>th</sup> International Conference on ultrafast phenomena**, 792-794 (2004)
- **R. Lopez**, R. F. Haglund, Jr. *Ion beam lithography and fabrication ordered arrays of VO<sub>2</sub> nanoparticles,* **Mat. Res. Soc. Symp. Proc.** **820**, R1.5.1-1/ R1.5.1-6 (2004)

- A.B. Hmelo, M.D. McMahon, **R. Lopez**, R.H. Magruder III, R.A. Weller, R.F. Haglund Jr. and L.C. Feldman, “*Fabrication of Metallic Nanocrystal Arrays for Nanoscale Nonlinear Optics*”, Ceramic Nanomaterials and Nanotechnology II, **Ceramic Transactions V. 148**, American Ceramic Society, 61-68, (2003).
- M. D. MacMahon, A. B. Hmelo, **R. Lopez**, W. T. Ryle, Allen T. Newton, Richard F. Haglund, L. C. Feldman, R. A. Weller, R. H. Magruder III. *Fabrication of ordered Metallic nanocluster arrays using focused ion beam*. **Mat. Res. Soc. Symp. Proc. 739**, 53-57 (2003).
- García-Llamas R, Gaspar-Armenta JA, Ramos-Mendieta F, **López R.**, Haglund Jr. RF and Ruiz R: *Injection of light into a planar dielectric wave guide of metallic walls*. **Proceedings of SPIE. 4439**: 88-94 (2001)

## DISSERTATION

- Rene Lopez Noriega, Doctoral dissertation: Metal Semiconductor Phase Transition in VO<sub>2</sub> nanocrystals 110 pages. Vanderbilt University. May 2002.

## CONFERENCES & PRESENTED PAPERS

- *Optical diffraction in ordered VO<sub>2</sub> nanoparticle arrays*. 2006 APS March meeting Focus session in Nanoscale Physics and Phase Transitions. 13-17 March 2006, Baltimore, MD USA
- Invited paper *Optical nonlinearities and the ultrafast phase transition of VO<sub>2</sub> nanoparticles*. SPIE Photonic West'06 International Symposium on “Ultrafast Phenomena in Semiconductors and Nanostructures X, 21-26 January 2006, San Jose, California USA
- *Nanostructured VO<sub>2</sub> particle arrays as active elements of photonic devices*. 12<sup>th</sup> International Workshop on Oxide Electronics, October 2-5, 2005, Cape Cod, MA.
- Invited paper *Size-dependent optical properties of VO<sub>2</sub> nanoparticle arrays*. NIRT Structure of nanocrystals workshop, December 5-8, 2004, Tempe, AZ.
- *The optical resonances of VO<sub>2</sub> nanoparticles in ordered arrays*. Spring Meeting, Materials Research Society (MRS), April 13, 2004, San Francisco, CA.
- Invited paper *Metal semiconductor phase transition in nanoscale vanadium dioxide precipitates formed in silica and sapphire by ion implantation*. International workshop on interactions between nanostructures and particle beams (MRS), March 11-13, 2004, Shanghai Institute of Applied Physics, Shanghai, CHINA.
- Invited paper *Metal semiconductor phase transition in nanoscale vanadium dioxide precipitates formed in silica by ion implantation*. Spring Meeting, Materials Research Society (MRS), April 21-25, 2003, San Francisco, CA.
- Invited paper *Metal semiconductor phase transition in nanoscale vanadium dioxide precipitates formed in silica and sapphire by ion implantation*. Conference on Accelerators Applications in Research and Industry (CARRI), November 12-16, 2002, U. of North Texas, Denton, TX.
- Invited paper *Metal semiconductor phase transition in nanoscale vanadium dioxide precipitates formed in silica by ion implantation*. Ion Beam Materials Modification (IBMM) conference, September 1-6, 2002, Kobe, JAPAN.

- Invited paper *Nanoscale features of the VO<sub>2</sub> phase transition*. Gordon conference on Point and Line defects in semiconductors, July 7-12, 2002, Colby Sawyer College, New London, NH.
- *Optical properties of the semiconductor/metal phase transition in VO<sub>2</sub>-precipitate SiO<sub>2</sub>-host nanocomposites*. 104<sup>th</sup> Annual Meeting American Ceramic Society, April 28-May 1, 2002, St. Louis, MO.
- *Metal-semiconductor phase transition in nanoscale vanadium dioxide precipitates formed in silica by ion implantation*. March Meeting American Physics Society, March 17-22, 2002, Indianapolis IN.
- *Metal-semiconductor phase transition in nanoscale vanadium dioxide precipitates formed in silica and sapphire by ion implantation*. Fall meeting Materials Research Society, November 26-30, 2001, Boston, MS.
- *Effects of the structural phase transition on the optical response of vanadium dioxide nanocrystals*. Meeting of the Nanoscale consortium, October 25-27, 2001, Baltimore MD.

## REFERENCES

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## PERSONAL INFORMATION

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