Dr. Dominick J. Casadonte, Jr.

Title:	Minnie Stevens Piper Professor
Education:	Ph.D., Purdue University, 1985; Postdoctoral Study, University of Illinois; Dreyfus Foundation Scholar/Fellow,1988-89; Fulbright Senior Scholar (France), 2000; NSF Discovery Corps Fellow, 2004-05
Research Area:	Inorganic & Materials Chemistry
Office:	Chemistry 125-D
Phone:	806-834-2746
Fax:	806-742-1289
Email:	Dominick.Casadonte@ttu.edu
	Research Group

Principal Research Interests

- The Chemical Effects of High-Intensity Ultrasound
- Environmental Remediation
- Nanomaterial Fabrication
- Supramolecular Chemistry
- Design of Photoactive Metallopolymers
- Photophysics/Photochemistry
- Chemical Education

Professor Casadonte's research interests focus upon the dynamics of unusual excited state processes as well as the fabrication of novel nanomaterial and molecular systems with potential applications as molecular photodevices, energy storage systems, catalysts, and environmental remediants. Several areas of research in his lab are aimed at understand the chemistry and physics of these high-energy events.

The Chemical Effects of High-Intensity Ultrasound

Acoustic cavitation produces temperatures in excess of 5000 K and pressures greater than 100 atmospheres during the adiabatic collapse of gas vacuoles in solution. These physical extremes are used to produce high-energy species not available by analogous thermal or photochemical routes. Sonication of mixed-metal powders in hydrocarbon solvents leads to the formation of intermetallic coatings which may have use as dehydrogenation catalysts and in thin film coatings. Ultrasound is also an effective means of removing hydrocarbon contaminants from aqueous media. This process may prove effective in the environmental remediation of waterborne pollutants. We have, for example, been able to degrade up to 1500 ppm of a variety of aliphatic, aromatic, and halogenated hydrocarbons in water to CO_2, H_2, and H_2O in slightly more than one hour.

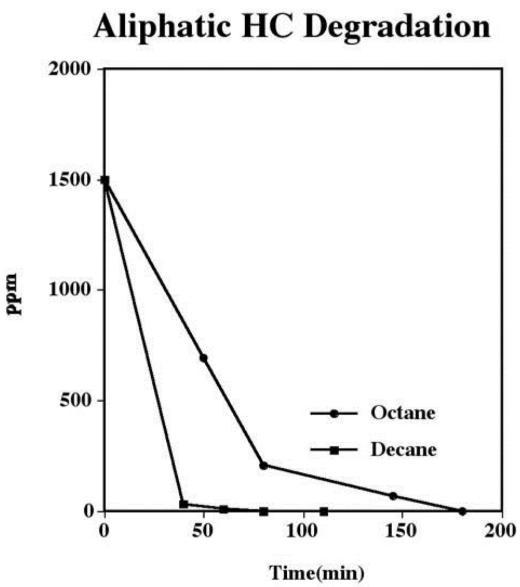

Figure 1. The sonolytic degradation of octane and decane in water.

The spring semester of 2000 was spent in Chambery, France on a Fulbright Scholarship. While there, Dr. Casadonte began preliminary studies on the application of pulsed ultrasound to enhance sonochemistry. It was found that with the appropriate pulsed waveform an enhancement of more than 300% in the rate of degradation of environmentally contaminants could be achieved relative to continuous ultrasonic irradiation. Little is known about the interaction of the pulsed sound field with the chemical species involved. Our group is also interested in exploring non-linear cavitation processes using variable frequency and heterodyne ultrasound. In this case, two different ultrasonic frequencies are input which produce a third frequency which is non-resonant with the cavitation sites. It is our belief that the non-linear cavitation phenomena produced by the multi-frequency ultrasound will lead to enhancements in the rate and efficiency of cavitation.We have already observed a 500% increase in the rate of acid orange degradation through the application of heterodyne ultrasound using a multi-frequency sonicator built in our lab.

Our other activities involving sonochemistry include the fabrication of metal phosphide semiconductor materials from organometallic precursors, generation of graphite intercalation compounds, and a facile sonochemical methodology for the formation of ionic liquids, and the formation of true nano-alloys of precise stoichiometry for fuel cell catalysis. We have also been developed a single-transducer variable frequency sonicator which allows our group to probe the effect of frequency on sonochemical activity in a systematic manner.

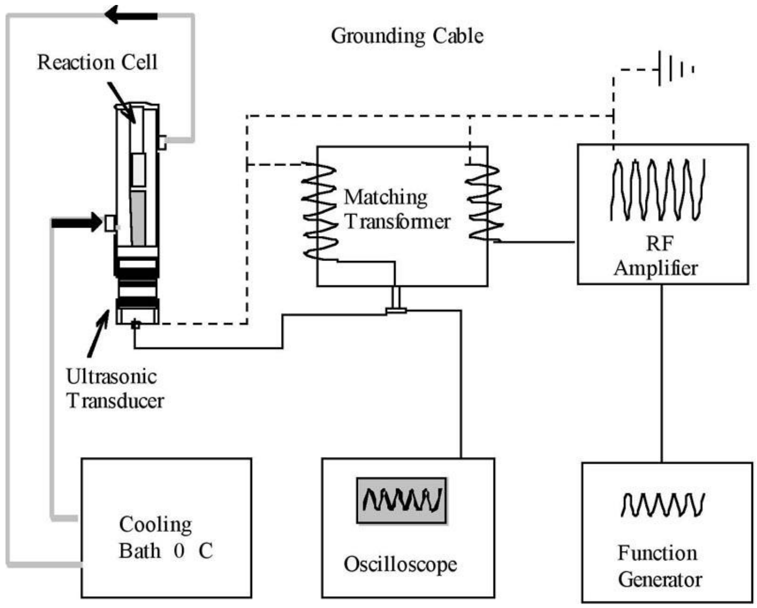

Figure 2. The Variable Frequency Sonicator.

Supramolecular Chemistry and the Design of Photoactive Metallopolymers

The goal of this research is an understanding of the spatial characteristics required for the fabrication of molecular photodevices. We have recently developed the first examples of photoactive multinuclear Cu(I) complexes containing bridging phosphines. We have also prepared multinuclear Cu(I) complexes containing phenanthrolines bound via oxyben bridges.

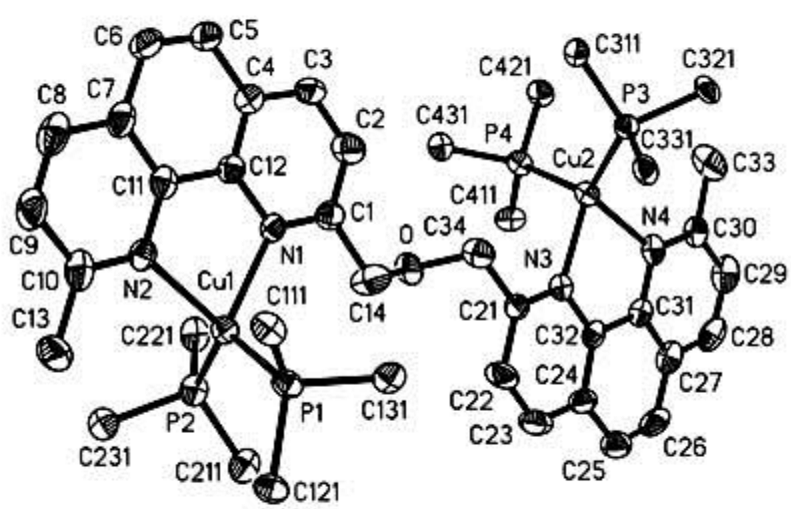

Figure 3. Crystal structure of [(PPh3)2Cu(dmp)-O-(dmp)Cu(PPh3)2]2+ (dmp = 2,9-dimethyl-1,10-phenanthroline)

Similar complexes have been catenated to form metallo-polymers possessing photo-induced charge-storage capacity. Our research group has recently synthesized a unique Cu(I) metallopolymer using polymerized phenanthroline acrylate as the ligand. We have synthesized a double helical species containing two phenanthroline units per Cu(I) (generating a Cu(I) channel in the middle of the polymer), and an asymmetric system containing one phenanthroline ligand and two coordinated triphenylphosphine ligands per copper. The polymer has photocapacitive characteristics, with measurable photocapacitance under 354 nm irradiation of approximately 65 µF/g (~600 mF/mole or 1.3 mF/m2). The mononuclear species displays no analogous photcapacitance. Metallopolymers of this type may have future applications in optical computing.

Photochemistry/Photophysics

Another aspect of Professor Casadonte's research includes the synthesis of complexes which display simultaneous emission from two or more distinct excited states. He has recently prepared a series of Cu(I) complexes containing phosphine sulfide ligands which emit from both charge transfer and intraligand emission excited states. Density functional calculations are currently underway in an attempt to understand the mechanism of multistate luminescence from these systems, which violate Kasha's rule.

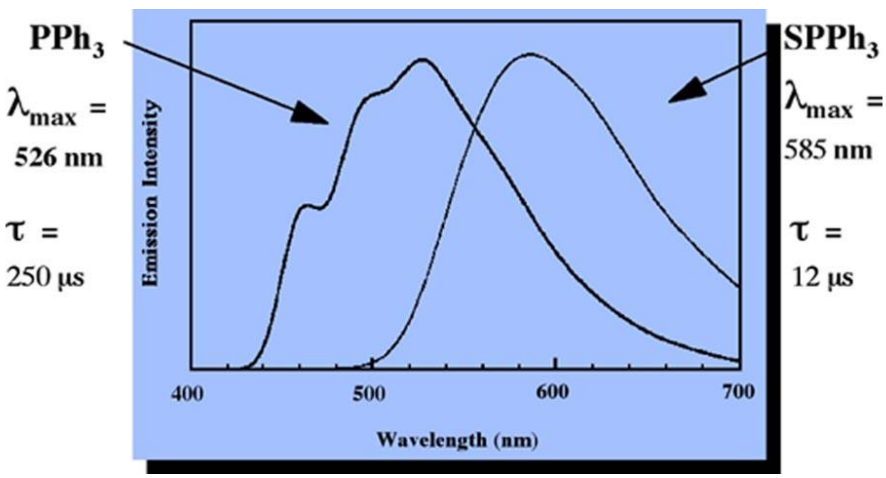

Figure 4. Luminescence Spectra of Cu(I) Phosphine and Phosphine Sulfide Complexes

Chemical Education

Professor Casadonte has an active interest in several areas of chemical education. In his recent role as an National Science Foundation Discovery Corps Fellow, professor Casadonte has explored the efficacy of an intergenerational learning and service program in the chemical sciences in elementary and middle schools, involving the use of senior citizens as secondary teachers at the 5th and 8th grade levels. Studies were performed on student learning enhancement, improvement in cognitive functioning among the seniors, and changes in attitudes between both the seniors and children during their curricular and extracurricular interactions.

Professor Casadonte has an active program in service learning. He has developed a laboratory course that teaches chemistry though the development of novel chemical demonstrations. The students are then required to "perform" their demo show for various K-12 audiences. Pre- and post-content and attitudinal assessment instruments have been developed to determine the effectiveness of this handson, project-based learning environment. He is currently working on the development of an intercollegiate service learning project.

A current research focus in the area of chemical education in the Casadonte group focuses on the exploration of the integration of mathematics and science into the K-12 curriculum. Through the auspices of a National Science Foundation GK-12 grant, Casadonte and a team of co-PI's on the Texas Tech campus have developed "Math-Science-Engineering Bridge Quartets (MSEBQ's), involving 2-3 Math/Science/Engineering graduate students and 2-3 Math/Science/Engineering high school teachers who form a learning/teaching community in order to develop and teach integrated math/science curriculum. One of the purposes of this study is to help break down artificial barriers that exist in many students' minds concerning the applications of math in science and vice versa.

Representative Publications

- **"Children's Attitudes and Classroom Interaction In an Intergenerational Education Program."** Chorn Dunham, C.; Casadonte, Jr. D.J. *Educational Gerontology* **2009,** 35(5), 453 – 464.
- **"Structural Analysis of Sonochemically Prepared PtRu Versus Johnson Matthey PtRu in Operating Direct Methanol Fuel Cells."** Stoupin, S.; Rivera H.; Li Z.; Segre C.; Korzeniewski, C.; Casadonte, Jr, D.J.; Inoued, H.; Smotkin, E.S. *Phys. Chem. Chem. Phys.***2008,** 10, 6430–6437.
- **"Applications of Sonochemistry and Microwaves in Organommetallic Chemistry."** Casadonte, D.J. Jr.; Li, Z.; Mingos *D.M.P. in Comprehensive Organometallic Chemistry III* Vol. 1; Edited by Robert H. Crabtree and D. Michael P. Mingos, Elsevier: Oxford, **2007,** pgs. 307-340 ISBN: 008044590.
- **"Facile Sonochemical Synthesis of Nanosized InP and GaP."** Casadonte, D.J. Jr.; Li, Z.; *Ultrasonics Sonochemistry* **2007,** 14(6), 757-760.
- **"PtRu Nanoparticle Electrocatalyst With Bulk Alloy Properties Prepared Through A Sonochemical Method."** Basnayake, R.; Li, Z.; Katar, S.; Zhou, W.; Rivera, H.; Smotkin, E.S.; Casadonte, D.J. Jr.; Korzeniewski, C; *Langmuir* **2006,** 22, 10446-10450.
- **"Hydration and Interfacial Water in Nafion Membrane Probed by Transmission Infrared Spectrscopy."** Basnayake, R,; Peterson. G.R.; Casadonte, D.J. Jr.; Korzeniewski, C.; *J. Phys. Chem. B* **2006,** 110, 23938-23943.
- **"The Use of Pulsed Ultrasound Technology to Improve Environmental Remediation: A Comparative Study."** Casadonte, Jr., D.J.; Petrier, C.; Flores, M. *Environ. Tech.* **2005,** 26(12), 1411- 1416.
- **"Enhancing Sonochemical Degradation of Environmental Contaminants Using Power-Modulated Pulsed Ultrasound: An Initial Study."**, Casadonte, Jr., D.J.; Petrier, C.; Flores, M. *Ultrasonics Sonochemistry* **2005,** 12(3), 147-152.
- **"Facile Sonochemical Synthesis of Graphite Intercalation Compounds."**, Jones, J. E.; Cheshire, M. C.; Casadonte, Jr., D.J.; Phifer, C.C. *Org. Letts.* **2004,** 6(12), 1915-1917.

- **"Photobleaching Comparison of Poly(methylphenylsilylene) and Poly(phenylsilyne)."** Thomes Jr., W.J.; Simmons-Potter, K.; Phifer, C.C.; Potter Jr., B. G.; Jamison, G.M.; Jones, J.E.; Casadonte, Jr., D.J. *J. App. Phys.* **2004,** 96(11), 6313-6318.
- **"Methanol Electrochemical Oxidation at Nanometer-Scale PtRu Materials."**, Korzeniewski, C.; Basnayake, R.; Vijayaraghavan, G.; Li, Z.; Shanhon, X.; Casadonte, D.J. *Surface Sci.* **2004,** 573 (1), 100-108.
- **"The Use of Pulsed Ultrasound Technology to Improve Environmental Remediation: A Comparative Study."** Casadonte, Jr., D.J.; Flores, M.; Petrier, C. *Environmental Technology* **2004,** Accepted for Publication.