Max Bertino Gets Ultra-light

The year 2003 was quite fruitful for **Max Bertino**. He published five papers based on work by UMR undergraduate student **João Sosa** (BS '02) and graduate students **Jared Hund** and **Carmen Doudna** (MS '02), and received a *Faculty Excellence Award*. His research, conducted in part in collaboration with Dr. **Nicholas Leventis** (NASA Glenn Research Center, Cleveland), focused on synthesis of ultralight materials (aerogels). These silica-based materials, which have a density 10 to 100 times smaller than water, have pores between 10 and 100 nm in diameter, and can be used for an array of applications, including catalysis, and, in form of thin films, electronics. A method was devised to load these materials at room temperature with metal clusters, and a typical example of the materials is shown in the figure to the right. From left to right, one can see a pure silica aerogel (totally transparent), an aerogel loaded with Au clusters (pink, not "gold," due to an effect called "surface plasmon," which is characteristic of small metallic aggregates), and three aerogels loaded with increasing amounts of Ag clusters (this time the plasmon is brown-yellow). The synthesis technique involves several steps, but the central one is the reduction of metal ions to metal atoms in aqueous solution. The reducing agent is something a physicist is well acquainted with: gamma rays from the core of our campus reactor. The radiation interacts with water molecules and produces, among other fragments, free electrons. These free electrons reduce metal ions to their neutral state. The reduced metal atoms aggregate to form clusters.

High resolution patterning of aerogels was successfully achieved by employing, instead of gamma rays, a collimated X-Ray beam source at Argonne National Laboratory. These experiments, conducted by undergraduates Joao Sosa (now a graduate student at Penn State), and **Kevin Johnson**, showed that patterns as small as a few microns can be realized. By moving the sample in front of the incident beam, complicated patterns, like our University's name, can be created (the length of the black bar is 400 microns, or 0.4 millimeters). Writing has never been lighter, at least for these physicists!

Recent publications by Max Bertino's group involving UMR graduate and undergraduate students:

Formation and Entrapment of Noble Metal Clusters in Silica Aerogel Monoliths by g-Radiolysis, J. F. Hund, M. F. Bertino, G. Zhang, C. Sotiriou-Leventis, N. Leventis, A. Tokuhiro, and J. Farmer, J. Phys. Chem. B 107, 465 (2003).

Synthesis of Aerogel-Metal Cluster Composites By Gamma Radiolysis, J. F. Hund, M. F. Bertino, G. Zhang, C. Sotiriou-Leventis, N. Leventis, A. Tokuhiro, and J. Farmer, Mater. Res. Soc. Symp. Proc. 740, I11.2 (2003).

Synthesis of Bimetallic Nanoparticles With High Aspect Ratio, C. M. Doudna, M. F. Bertino, F. D. Blum, A. T. Tokuhiro, D. Lahiri-Dey, S. Chattopadhyay, and J. Terry,", Mater. Res. Soc. Symp. Proc.740, I7.15 (2003).

Radiolytic Synthesis of Bimetallic Ag-Pt Nanoparticles With High Aspect Ratio, C. M. Doudna, M. F. Bertino, F. D. Blum, A. T. Tokuhiro, D. Lahiri-Dey, S. Chattopadhyay, and J. Terry, J. Phys. Chem. B 107, 2966 (2003).

High Resolution Patterning of Silica Aerogels, M. F. Bertino, J. F. Hund, J. Sosa, G. Zhang, C. Sotiriou-Leventis, N. Leventis, A. T. Tokuhiro, and J. Terry, J. Non-Cryst. Solids 333, 108 (2004).