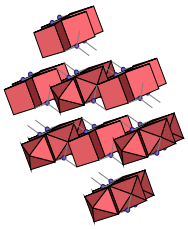
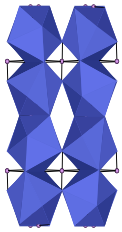
Research Projects in Cleary's lab

New lanthanide thiophosphates. Lanthanide thiophosphates present interesting extended inorganic structures. They also have potential applications in the development of new radiation detectors and nonlinear optical materials. In our lab, we have synthesized and characterized a number of these compounds and work continues in this area. Students working in this area learn glassblowing, high temperature crystal growth, spectroscopy, and x-ray diffraction.

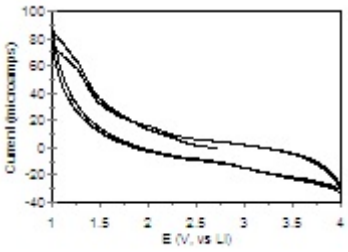


$LuPS_4$ viewed parallel to the van der Waals gap (LuS_7 polyhedra, blue P atoms).



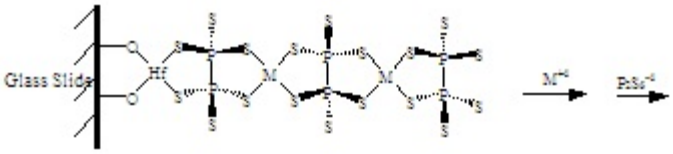
Structure of $ErPS_4$ viewed along the tetragonal a axis.

New lithium batteries. We have developed some new materials that have shown promise as electrodes for new lithium batteries. We focus on electrodes that can be produced from inexpensive starting materials and that are lightweight. Students working in this area learn electrochemistry, cell construction, and aqueous metal ion chemistry.



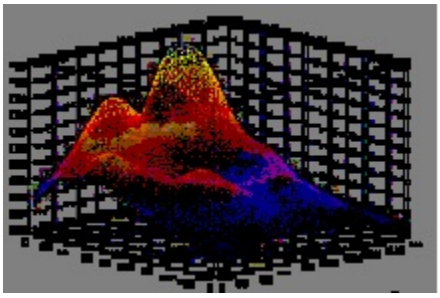
Cyclic voltammogram of $Ni_2P_2O_6$/Li cell.

Thin films. Many of the materials produced in our lab will be of more practical use if they can be fabricated into this films. Hence, we have a line of research dedicated to producing thin films of the compounds synthesized in our lab. The end use of such films would be as optical components and chemical sensors.



Schematic representation of the dipping process to produce a thin film of MP_2S_6 (or $M_2P_2S_6$ using a M^{+2} metal ion).

Photoelectrolysis of water. In collaboration with researchers at several other colleges and universities, we are examining a series of metal oxides looking for those which catalyze the reaction $2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$ in the presence of sunlight. Students working on this project would learn about combinatorial chemistry, lasers, photochemistry, and computer interfacing.



3-D surface plot of photocurrent generated from a compound formed from the oxides of Al, Fe, Cs, and Cr.