Polymer-Inorganic Composites for Lithium Batteries

Hypothesis: Electrochemical charge transfer reactions occur within a couple nanometers of a battery electrode. Electrolyte degradation, which limits the lifetime of lithium batteries, can be prevented by controlling the interface between the electrolyte and the electrode.

Results: We are able to synthesize 11 nm gold particles with narrow size distribution (Figure 1). We can attach different size molecules, called ligands, to the surface of the particles to prevent agglomeration. The length of the ligands determines the spacing between the particles. We will measure the electrical conductivity of the gold nanoparticles as a function of the spacing to determine the maximum distance that an electron can tunnel. This dimension must be known to design an electrode that is stable at high voltage.

Interesting findings: During ligand exchange, we found that the gold nanoparticles segregate to the water-"oil" interface forming a dense layer called a super lattice that appears gold (Figure 2).

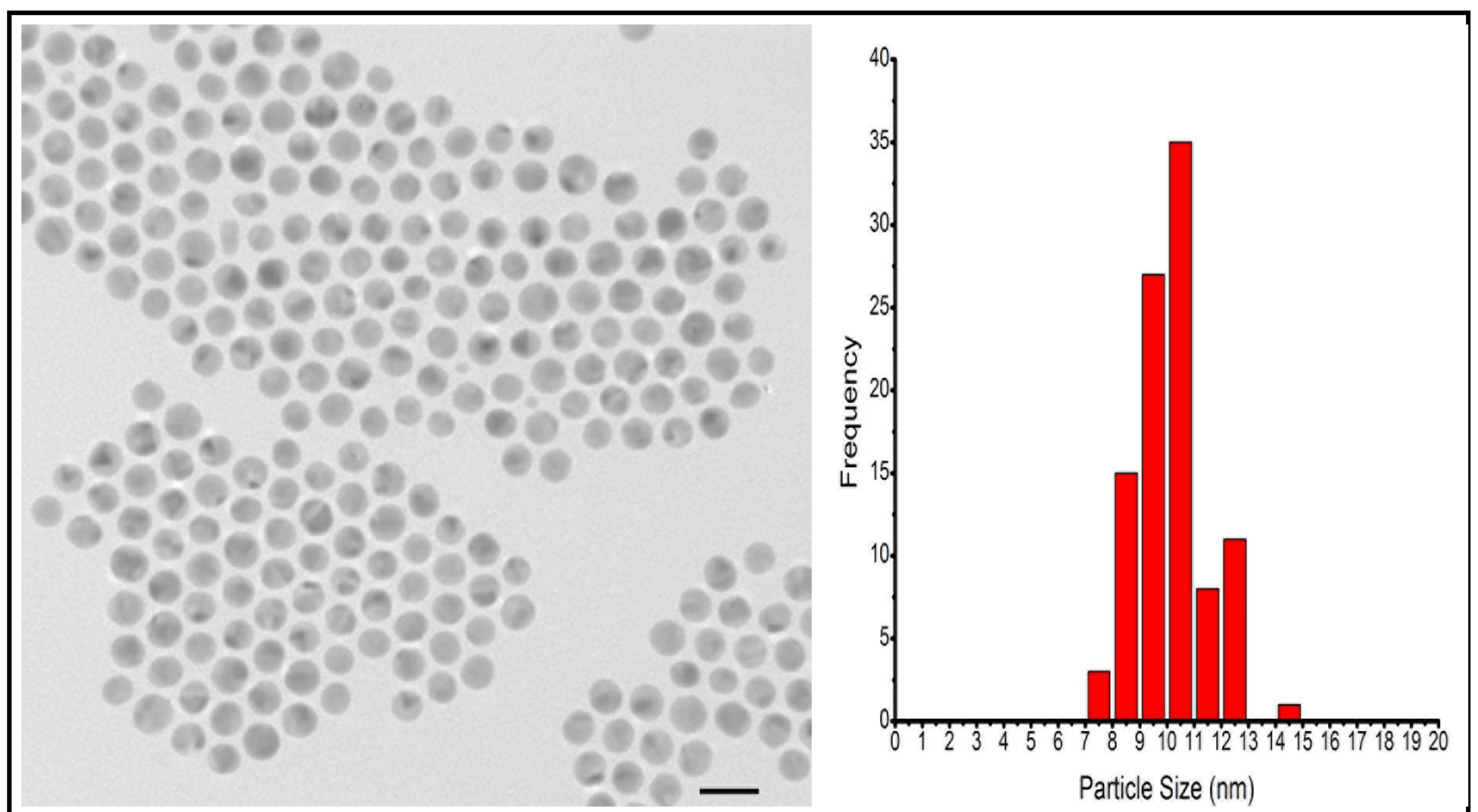

Figure 1. Transmission electron micrograph (left) and size distribution (right) of gold nanoparticles.

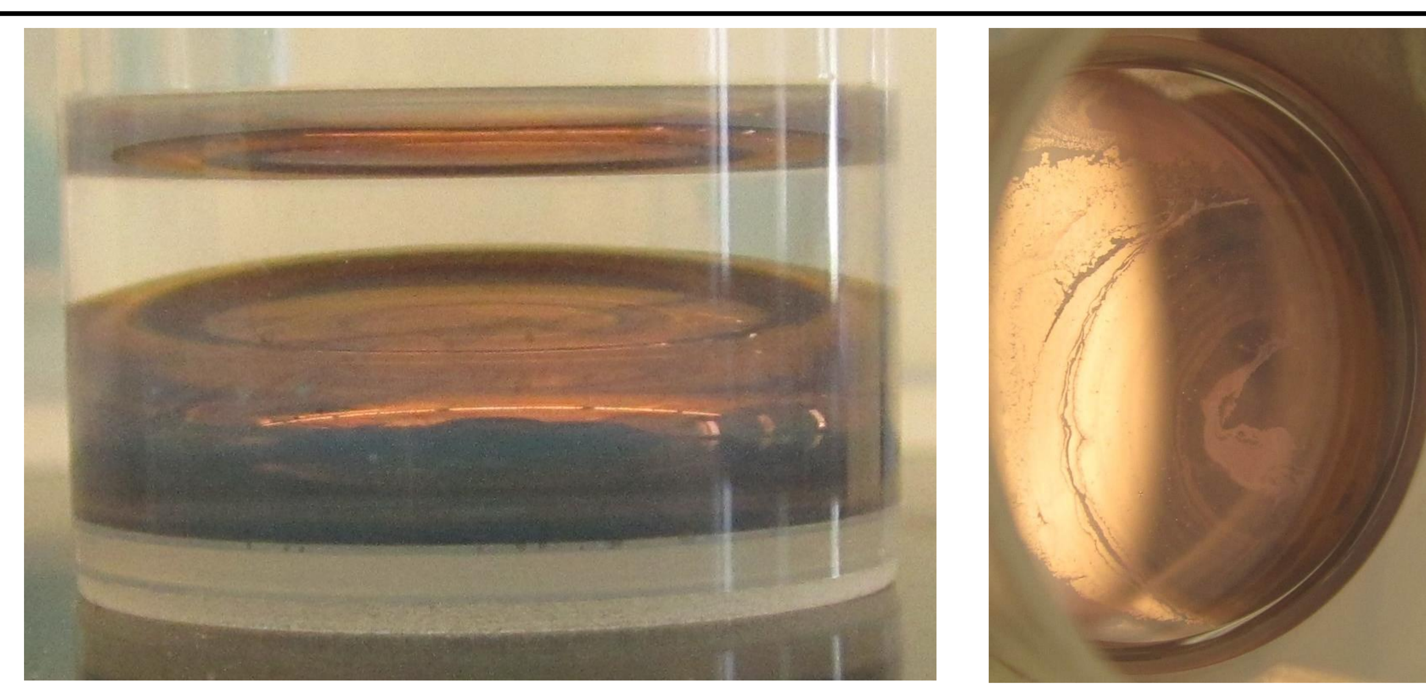

Figure 2. Optical image of the gold super lattice at the water-"oil" interface.

Future Work:

1. Optimize the process of transferring the gold film from the liquid interface to a solid subtrate where we can measure electrical conductivity.
2. Measure electrical conductivity of gold nanoparticles.
3. Incorporate into block copolymer electrolyte to form model electrode.
4. Investigate voltage stability of model electrode.

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