QUANTUM CONFINEMENT EFFECTS IN ELECTRODEPOSITED COMPOUND SEMICONDUCTORS FORMED USING EC-ALE

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Electrochemical atomic layer epitaxy (EC-ALE) is the electrochemical analog of atomic layer epitaxy (ALE). Both methods are based on surface limited reactions, that is, on the deposition of a compound one atomic layer at a time. In the case of an electrochemical deposition, underpotential deposition (UPD) is another name for an electrochemical surface limited reaction. The idea is that if a deposit is formed one atomic layer at a time, then it will be 2D growth, 3D growth will be avoided, it will be epitaxial.

One of the major benefits of EC-ALE is that you have atomic level control over the deposition process. This makes the formation of superlattices possible. There are a range of compound that are being electrodeposited, including a number of the II-VI, III-V, and IV-VI compounds. These compounds are considered photonic materials, and thus of interest in the formation of devices which either emit or absorb photons.

By confining the growth of these materials, their band gaps, the energies that they emit or absorb, can be manipulated, as with a particle in a box. This can be as simple as formation of a very thin deposit, one thinner then the Bohr radius for electron hole pairs in the material, or formation of a superlattice, or by the formation of nanoclusters of the materials.

Recent results from this lab will be discussed, where quantum confinement has been observed. Superlattices of PbSe/PbTe have been formed, as have thin films of each of these compounds. Quantum confinement has been observed in each case. Recently, work has begun on the use of templates and EC-ALE to form nano clusters, and those results will be described as well.