Surface Enhanced Raman Spectroscopy of Group IV Semiconductor Electrodeposition and Deoxygenation

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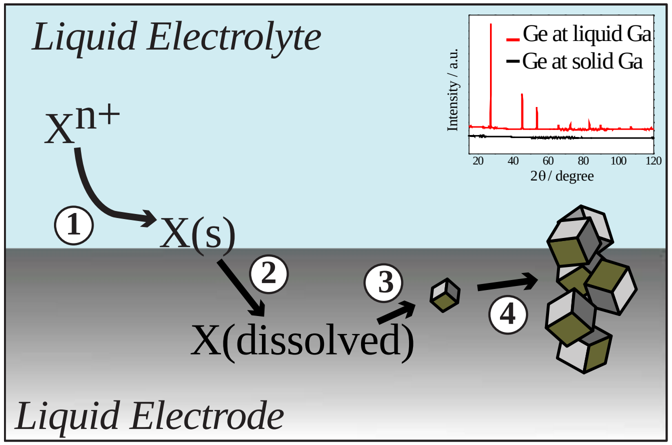
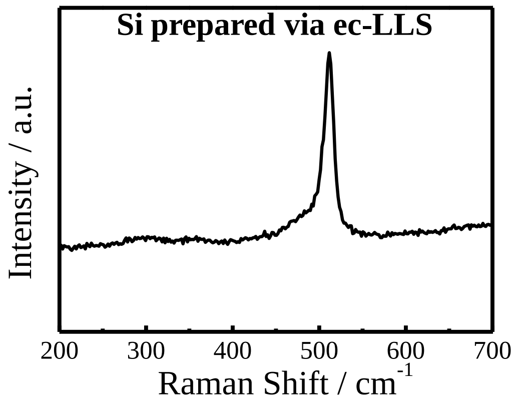
The overarching thesis of this work is to develop non-energy-intensive synthetic methods for crystalline, inorganic semiconductor materials with desirable optoelectronic properties. In the initial stages of this work, we discovered a fundamentally new and unexplored strategy for electrochemically synthesizing crystalline semiconductors from aqueous solutions containing dissolved oxide precursors. Through the use of a liquid metal electrode that simultaneously acts as an electrode (i.e. electron source for the reduction of dissolved, oxidized species) and as a solvent for recrystallization, we have demonstrated and reported the electrosynthesis of crystalline Ge from an aqueous solution of dissolved GeO_2 at room temperature. We have dubbed this as an electrochemical liquid-liquid-solid (ec-LLS) proces. This method is not specific to either the target semiconductor or liquid metal, as we have successfully produced crystalline Ge, Se, and GaAs with several low-melting point metals. The essence of this process is a dissolution of the initial amorphous electrodeposit, followed by supersaturation, and then precipitation/crystallization. Under the auspice of electrochemical control, these steps can be regulated and the resultant properties of the crystallized semiconductor can be tuned. We successfully demonstrated the ec-LLS process can yield Ge films that function as high-capacity electrodes in electrochemical energy storage technologies *as-prepared*.





<u>As-electrodeposited</u> crystalline Ge used as a battery device electrode