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Electrochemical Synthesis of Metal Chalcogenides Nanostructures

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Nanoengineered materials with advanced architectures are critical building blocks to modulate conventional material properties or amplify interface behavior for enhanced device performance. One of most challenging steps in nanoscale science and engineering has been to produce nanoengineered materials with well-controlled dimension and morphology without utilization of complex, time-consuming, and expensive synthesis processes. In addition to synthesis of simple one-dimensional nanostructures (i.e., nanowires, nanofibers, nanotubes, and nanoribbons), the development of corresponding hierarchical nanostructures in a scalable, high throughput and cost-effective manner is essential to advance the next generation of electronics, optoelectronics, sensors, and energy generation/storage technology.

Although physical synthesis methods are able to produce nanostructures with good morphological and dimensional control, such methods are intrinsically limited in terms of scalability and throughput. Solution based synthesis methods including polylol process, hydrothermal, solvothermal, ultrasonic assisted method, biological assisted method, spontaneous oxidation, microwave-polylol method are able to control the morphology and diameter. However, they typically produced a few micron long nanostructures with limited structure complexity.

Galvanic displacement reaction (GDR) is a simple and versatile, yet powerful, technique for selectively changing the composition and/or morphology of nanostructures. GDR takes place via a spontaneous electrochemical reaction driven by the difference in redox potentials between the solid material to be displaced and the ions in the electrolyte and is well suited to high-throughput processing under nearly ambient conditions.

Metal chalcogenides are promising materials for various applications including sensors, thermoelectric (TE) devices, phase change memory (PCM) and topological insulator, drawing a significant interest in their nanodevices and systems fabrication. Our group have been working on the development of electrochemical routes for the synthesis of various metal chalcogenides including two-dimensional (2-D) thin films, one-dimensional (1-D) nanowires and nanotubes, and quasi zero-dimensional (0-D) superlatticed nanowires and heterostructures including i.e., nano-peapods, dumb-bell like structures) and investigates their structural related properties. In this presentation, we will present our current work on metal chalcogenides nanostructures synthesis by electrochemical methods.