**Chemistry for Nano, and Nano for Medicine & Energy**

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Over the last 18 years, our laboratory has focused on the designed chemical synthesis, assembly and applications of uniform-sized nanocrystals. In particular, we developed a novel generalized procedure called as the “heat-up process” for the direct synthesis of uniform-sized nanocrystals of many metals, oxides, and chalcogenides.1

For the last 10 years, our group has been focused on medical applications of various uniform-sized nanoparticles. Using 3 nm-sized iron oxide nanoparticles, new non-toxic MRI contrast agent was realized for high resolution MRI of blood vessels down to 0.2 mm.2 Very recently, we report on the biocompatibility evaluation and MR imaging of extremely small and uniform-sized iron oxide nanoparticles in large animal models including most clinically-relevant non-human primates. These biocompatible iron oxide nanoparticles are successfully used as T1 MR contrast agent for high-resolution MR angiography of macaque monkeys.3

I will present recent advances on the fabrication of ultraflexible and stretchable electronic and optoelectronic devices integrated with various functional nanomaterials and their applications to wearable and implantable healthcare devices. We reported graphene-hybrid electrochemical devices integrated with thermo-responsive micro-needles for the sweat-based diabetes monitoring and feedback therapy.4,5 We reported the designed fabrication of multifunctional wearable electronic devices for sensing, data storage, and drug-based feedback therapy of motion-related neurological disorders such as Parkinson’s disease.6 We introduced electromechanical cardioplasty using an epicardial mesh made of electrically conductive and mechanically elastic silver nanowire-rubber composite material to resemble the innate cardiac tissue and confer cardiac conduction system function.7

Recently we have focused on the architecture engineering of nanomaterials for their applications to lithium ion battery, fuel cell electrocatalysts, solar cells, and thermoelectrics. We reported the first demonstration of galvanic replacement reactions in metal oxide nanocrystals, and were able to synthesize hollow nanocrystals of various multimetallic oxides including Mn3O4/γ-Fe2O3.8 We report a simple synthetic method of carbon-based hybrid cellular nanosheets loaded with SnO2 nanoparticles.9 These iron oxide-based nanomaterials exhibited very high specific capacity and good cyclability for lithium ion battery anodes. We present a synthesis of highly durable and active electrocatalysts based on ordered fct-PtFe nanoparticles and FeP nanoparticles coated with N-doped carbon shell.10,11 We use nanochemistry to stabilize bulk bismuth telluride (Bi2Te3) that violates phase equilibrium, namely, phase-pure n-type K0.06Bi2Te3.18. Incorporated potassium and tellurium in Bi2Te3 far exceeds their solubility limit, inducing simultaneous increase in the electrical conductivity and the Seebeck coefficient along with decrease in the thermal conductivity. Consequently, a high power factor of ~43 μW cm–1 K–2 and a high thermoelectric figure of merit (*ZT*) > 1.1 at 323 K are achieved.12

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