Metal Nanoparticle Foundry with Redox Active Polymers: Science and Applications

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Noble metal materials (metal nanoparticles, MNPs) with nanometer-scale dimensions and particular shapes have attracted great interest for their special physico-chemical properties, such as large surface area, surface plasmon characteristics, and unique optical and electronic properties. These materials have potential applications in the areas of catalysis, optoelectronics, sensors, biomedical materials, and in the energy field. In order to take full advantage of the unique physical and chemical attributes, it is necessary to explore synthetic methods for controlling the shape, size, and composition of the noble metal materials. In this presentation we first provide a short historical overview of their synthesis. We then "zoom in" and discuss in detail, how these MNP-containing materials can be prepared at surfaces via redox reactions using polymer brushes, and how they can be directly, and in-situ, synthesized from salt electrolyte solutions employing hydrogels of redox responsive organometallic polymers, such as poly(ferrocenylsilanes), (PFS). Following an outline of the unique physical properties of the resulting composite materials, various applications will be elucidated. These applications include MNP hybrid films for catalysis in glass microreactors, electrocatalysis, colorimetric sensors, catalytic and stimulus responsive membranes, antibacterial biomaterials, and plasmonic heating for optical device engineering. The presentation will conclude with an outlook discussing the future potential of MNPs, from the speaker's perspective.