# Galvanic replacement reaction (GRR) strategy as a powerful tool for multifunctional nano-materials

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**ABSTRACT**

Galvanic replacement reaction (GRR) involves a redox couple wherein oxidation of a metal and deposition of another metal occurs simultaneously. GRR, occurring on a nanoscale template material, can yield nano structures with tunable morphologies and composition in a very facile, simple, and rapid manner. Here, we showcase the versatility of GRR to effectively fabricate metallic micro/nano structures and metal-semiconductor heterostructures using a rapid and simple solution phase synthetic methodology. Specifically discussed here are the following: i) GRR synthesis of metallic (mono/bi) dendritic micro/nano structures; ii) template assisted GRR based synthesis of $Cu_2O$-Ag semiconductor-metal heterostructures. The metallic dendritic structures (mono/bi metallic) are demonstrated to have superior catalytic activity for the reduction reaction of 4-nitrophenol to 4-aminophenol. Such dendritic structures are excellent self-cleaning materials exhibiting superhydrophobicity (contact angles > 150$^o$). Presented results focus on the various aspects of the synthesis of monometallic (Cu) and bimetallic (Cu-Sn; Cu-In; Cu-Ni; Cu-Ag) dendritic structures highlighting their immense potential in variety of applications. The controllable fabrication of $Cu_2O$-Ag heterostructures starting with $Cu_2O$ particles as sacrificial template material in the presence of surfactant (5-Sulfosalicylic acid, 5-SSA) will be discussed in detail. The added surfactant (5-SSA) is found to be indispensible for the heterogeneous nucleation of Ag NPs on $Cu_2O$ template particle. The effect of facet selectivity during GRR deposition of Ag on different crystal facets of $Cu_2O$ particles has also been probed. Such heterostructures are highly useful for SERS based chemical sensing. The results for synthesis of $Cu_2O$-Ag heterostructures presented here, is one of the very few reports on utilizing $Cu_2O$ as template for Ag nanoparticle deposition on variety of templates (octahedra, cubes, cuboctahedra) that shows evidences of facet selectivity during GRR. The gamut of multifunctional micro/nano structures amenable through GRR synthetic strategy highlights the power and versatility of this synthetic methodology in accessing micro/nano structures tailored for desired applications.