Electron microscopic study of various metallic nanostructures

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Noble metal nanostructures have been under extensive scientific scrutiny for the last decades because of their use in applications such as catalysis, optics, electronics, chemical sensing and surface-enhanced Raman scattering (SERS). The properties of metal nanostructures largely depend on their size, shape and composition, therefore, a great variety of nanostructures (spherical nanoparticles, nanorods, nanotriangles, nanoshells, nanoboxes) have been synthesized with controllable size and composition. Recently, there is considerable interest in porous nanostructure due to their advantages of high specific surface area, low density to save raw materials and reduce the cost. They are also expected to show enhanced catalytic activities compared to their bulk solid counterparts. As a result, considerable effort has been made to synthesize porous nanostructures.

The galvanic replacement reaction provides a very simple and effective method to prepare metal nanowires with porous walls from metal nanostructures having a lower standard electrode potential compared to that of the target material. In general most of the approaches have utilized silver metal as sacrificial template, while the galvanic exchange with other sacrificial metals (e. g. other transition metals such as copper or nickel) has rarely been applied. However, other transition metals are cheaper than silver (Ag/Ag^{+}) and have a low standard electrode potential (Me/Me^{n+}) – trying to make a variety of porous nanomaterials by galvanic exchange reaction is a notable challenge.

In this study we demonstrate a protocol for synthesizing porous gold, platinum and palladium nanorods via galvanic exchange reaction using nickel nanostructures as a sacrificial template. Nickel nanorods were grown in porous alumina template by electrodeposition technique. Porous nanorods of gold, platinum and palladium were produced by exposing nickel nanorods to the aqueous solutions of the corresponding metal salt. The morphology and the structure of these porous nanorods have been studied by scanning and transmission electronmicroscopy.