Advanced Metallic Nanostructures for Electrocatalytic Applications

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Electrocatalysts play a vital role in the development of renewable energy technologies based on electrical-chemical energy conversions, such as fuel cells, electrolyzers, photoelectrochemical solar cells and metal-air batteries. Nanomaterials have emerged as promising candidates for such electrocatalytic applications, but in many cases the performances have not met the technical and cost-effectiveness standards for practical implementations. Comprehensive understanding is yet to be developed for the structure-property relationships of the electrocatalysts. While traditionally it relies on the studies of well-defined extended surfaces as model catalysts, knowledge gaps are also realized to be present between the extended surfaces and nanomaterials, probably not only due to the intrinsically different crystalline and surface structures at these two extreme size scales, but also caused by the challenges in probing the active sites and reaction pathways on nanostructured materials.

This presentation aims to discuss two examples of our efforts on tailoring metallic nanostructures for electrocatalytic applications: *i) highly dense Cu nanowires for the electroreduction of* CO_2 *and CO*, and *ii) Co/Pt core/shell nanoparticles as sustainable electrocatalysts for the oxygen reduction reaction (ORR)*. These nanostructures are characterized by combining electron-based microscopic imaging, diffraction and elemental mapping, while the surface structures are probed by using surface-specific adsorption/desorption of small molecules (e.g., CO_{ad} and OH_{ad}). The gained structural information is correlated to the measured catalytic activity, durability and/or selectivity, based on which computational simulations are further performed to understand the established structure-property relationships, depict the active sites and reveal the catalytic enhancement mechanisms. Our work highlight the great potential of tailoring nanostructured materials toward the advancement of renewable energy technologies.