

Transmission electron microscopy of nanoparticle active sites

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This poster will present TEM characterisation of the catalytic active surfaces of ruthenium and ruthenium-platinum nanoparticles using S/TEM imaging and STEM-EDX analysis techniques.

A major challenge in the development of the state-of-the-art metal nanoparticle catalyst is the trade-off between activity and stability. In particular, platinum and ruthenium nanoparticles exhibit excellent activity toward different fuel cell reactions but suffer from poor durability (due to reaction intermediate poisoning on platinum) and stability (due to dissolution of ruthenium ionic species). It is understood that the catalytic properties of nanoparticle catalysts are governed by their size, shape, composition and the crystallographic planes that terminate the nanoparticle surfaces. Therefore, proper characterisation of the catalytic active sites is critical to the understanding of the structure-property relationship of the nanoparticles in order to better design catalysts that are both active and stable.

In a previous report, hourglass-shaped ruthenium nanoparticles exclusively bound by {0001} and {10-11} facets have been synthesised via a thermodynamically growth route in solution.^[1] Owing to the low-index facets, these nanoparticles are found to be highly stable (>200 cycles) while maintaining high activity, compared to all previous ruthenium nanoparticles which lost most of their activity after a few cycles. S/TEM characterisation of the facets after various cycles (up to 1000 cycles) are presented to reveal their behaviours toward catalysing oxygen evolution reaction.

The unique features of the hourglass nanoparticles are extended to ruthenium-core-platinum-shell nanoparticles, by preferentially growing a thin layer of platinum onto Ru{0001} surfaces. TEM and HAADF-STEM imaging, and STEM-EDX analysis are presented to elucidate the ruthenium-platinum structure and the platinum surfaces for methanol oxidation reaction.

Reference

^[1] J. Watt, C. Yu, S. L. Y. Chang, S. Cheong, R. D. Tilley, J. Am. Chem. Soc. 135, 606-609 (2013).