Light Enhanced Catalysis

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Abstract:

Here we elucidate the potential of light pre-treatment in enhancing the catalytic O_2 activation for oxidation reactions. Formic acid oxidation was selected as the model oxygen activation reaction. The effects of light pre-treatment on Pt loaded on TiO_2, CeO_2 and SiO_2, as well as Au and bimetallic Au-Pt loaded on TiO_2 were examined.
The catalytic reactions were studied under different illumination conditions; dark catalysis (i.e. no illumination), dark catalysis with light pre-treatment and photocatalysis (i.e. continuous illumination). For the Pt-loaded catalysts, the key active species were surface active oxygen (PtO_{ads} and O_{ads}) under the dark catalytic condition with and without light pre-treatment while under the photocatalytic condition, photogenerated holes and electrons are believed to form hydroxyl radicals (•OH) and superoxide radicals (•O_2-), respectively, for CeO_2, TiO_2, Pt/TiO_2 and Pt/CeO_2. Unexpectedly, Pt/SiO_2 showed the highest activity under the dark catalytic condition. The distinctly shaped Pt deposits on the SiO_2 surface, which promote a greater number of sharp edges/corners at the interface, are believed to be advantageous for dissociating and activating adsorbed oxygen species compared to the hemispherical Pt deposits on TiO_2 and CeO_2. The cubo-octahedral shape of the Pt deposits is thought to be responsible for the observed high activity of Pt/SiO_2 for the dark catalytic oxidation of formic acid.
Similar to Pt/TiO_2, Au/TiO_2 performance is enhanced upon UV pre-treatment. We also considered the effect of visible light pre-treatment on the synergy within TiO_2-supported bimetallic Au-Pt deposits with the potential for exploiting the Au LSPR (local surface plasmon resonance) effect on oxygen activation being presented.

Biographical Statement of speaker:

Professor Rose Amal is a UNSW Scientia Professor and an ARC Laureate Fellow. Her current research focuses on designing nanomaterials for solar and chemical energy conversion applications and engineering systems for solar induced processes, using the sun's energy as a clean fuel source.