Supported Metal Nanoparticles for Catalytic Applications

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Abstract: Supported metal nanoparticles represent an important class of heterogeneous catalysts, catalysing several reactions, including selective hydrogenation/hydrogenolysis and oxidations. Three sites: metallic sites, metal-support interfacial sites, and support sites play crucial roles in controlling the catalytic properties of these materials. In this lecture, I will present our group's efforts to tune these active sites and their impact on catalytic performance, with a focus on reactions critical for transitioning to a green and sustainable future, such as biofeedstock conversion. We have reported the superior properties of many supported bimetallic nanoparticles compared to their monometallic analogues for various hydrogenation and oxidation reactions. I will discuss synthesis strategies to tune the size, composition, and nanostructure of these bimetallic nanoparticles and correlate them with their catalytic properties.

Traditionally, support materials are considered inert and are used primarily to stabilize nanoparticles and prevent sintering during high-temperature catalytic reactions. I will present some results where we demonstrate that supports play an active role in catalysis. They can alter reaction mechanisms, thereby improving selectivity, and influence the structural features of the metallic active sites, leading to enhanced activity and stability of supported metal catalysts. I will also discuss how support materials direct the nanostructures of monometallic and bimetallic nanoparticles and their catalytic properties in liquid-phase reactions.

Finally, I will outline strategies to fine-tune metal-support interfacial sites through optimized catalyst synthesis and heat treatment protocols. This talk aims to emphasize the role of supports, extending beyond nanoparticle stabilization, in influencing the catalytic activity and overall performance of supported monometallic and bimetallic catalysts.

Key publications:

Sankar et al. *ACS Nano* 2012, 6, 8, 6600.

Sankar et al. *Chemical Society Review* 2012,41, 8099.

Paalanen et al. *Catalysis Science and Technology* 2013,3, 2869.

Luo et al. Nature Communications, 2015, 6, 6540.

Macino et al. *Nature Catalysis*, 2019, 2, 873.

Sankar et al. *Chemical Reviews* 2020, 120, 8, 3890.

Bio sketch

Sankar obtained his Bachelors and Masters in Chemistry from India. Then he got his PhD in Heterogeneous Catalysis from the National Chemical Laboratory, Pune, India. After finishing his PhD, he moved to the Cardiff Catalysis Institute as a Postdoctoral Researcher. In 2011 he was awarded the prestigious Marie-Curie Intra-European Research Fellowship to continue his research at Utrecht University. In 2014, he moved back to the Cardiff Catalysis Institute and started his independent research group with a University Research Fellowship. Now he is a senior lecturer in Physical Chemistry at Cardiff University.