The CATALYSIS SOCIETY of Metropolitan New York
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Wednesday, November 9th, 2022 at 4:00pm EST
Virtual Meeting: Zoom

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Simple Synthesis of Highly Dispersed Supported Metal Catalysts via Switched Solvent Synthesis and Chelate Fixation

Supported atomically dispersed metal catalysts (sometimes called single-atom catalysts. i.e., SACs) are at the frontier of catalysis research, promising the combined advantages of well-defined sites and high selectivity with high stability and easy separation characterizing solid catalysts. These catalysts have the potential to provide unique catalytic performance due to intimate electronic interactions between the isolated active site and the supports, which are ligands. To fully exploit the potential for commercial applications of atomically dispersed metals, the development of scalable and facile synthesis methods that can produce high loadings of isolated active sites with high stability is required. Typical syntheses of single atom catalysts employ very low areal loadings of metal and/or anchoring sites (e.g., oxygen deficiencies in ceria, nitrogen dopants in carbon). We have therefore striven to develop a synthesis method that can achieve higher loadings while not generally requiring anchoring sites. Incipient wetness impregnation does not give such control, as without any metal-support interaction the metal precursors remain in solution and are brought to the drying surfaces, resulting (in many cases) in large, polydisperse particles. While electrostatic adsorption provides a strong precursor-support interaction during the metal adsorption step, our hypothesis is that during drying, surface tension forces take over as the surface dries, and nano-droplets form that give rise to small nanoparticles. We hypothesized that nanoparticle formation can be prevented by adding a solvent having a) a dipole moment larger than water, so as to displace the hydration sheaths around the metal precursors, and b) a low surface tension that allows wetting of the support surface. In this case, which we term switched solvent synthesis (SwiSS), metal precursor agglomeration is hindered as the solvent is removed, even without anchoring sites (Figure 1c). Further stabilization of metal species may be obtained using the addition of a chelating agent to bind with the metal precursors and the support, which we term chelate fixation (CheFi). This talk will address our recent results exploring these SwiSS and CheFi approaches for the synthesis of high loading, highly dispersed (and often isolated) metal on carbon and oxide supports, initial attempts to characterize these species, along with some preliminary catalytic results. Prospects for future application of these approaches will be briefly discussed.

Speaker Bio

Professor Chris Williams received a Bachelor of Chemical Engineering degree from the University of Delaware in 1993 and a PhD in Chemical Engineering from Purdue University in 1997. Following a post-doctoral appointment in the Physical and Theoretical Chemistry Department at Oxford University, he joined the faculty in the Department of Chemical Engineering at the University of South Carolina in 1999, and is currently a Professor serving as the Undergraduate Program Director. His research interests are in the area of heterogeneous catalysis and surface science, with a particular emphases on studying solid-liquid catalytic interfaces with in-situ/operando spectroscopy and developing novel synthetic approaches to producing highly dispersed monometallic and bimetallic catalysts for a variety of applications. He has over 125 publications in peer-reviewed journals, and has been a visiting faculty at Osaka University, University of Poitiers, Dalian University of Technology, and Xiamen University. He is currently the USC Site director for the Center for Rational Catalyst Synthesis, an NSF I/UCRC dedicated to turning the "art of catalyst preparation into a science". He also currently serves as an Associate Editor for the RSC journal *Catalysis Science and Technology*.

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Presentation	**4:00 PM**	**Annual Membership Dues**	**$35 (*Students* = $15)**

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