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Literature Seminar

When: **Monday, March 28, 2022**
Time: **12:00 p.m.**
Location: **SRB 139**

FABRICATION OF SINGLE-ATOM CATALYSTS (SACs) BY ELECTROCHEMICAL METHODS

Abstract

Single-atom catalysts (SACs), also referred to as Atomically Dispersed Metal Catalysts (ADMCs), is an emerging type of catalyst that maximizes the strengths of homogeneous and heterogeneous catalysts; high atom economy, activity and scalability while resolving the drawbacks of these two classes of catalysts.[1] This makes SACs a prospective asset in industrial, energy and environmental applications. As an emerging area, scientists need to conduct research to understand the chemistry behind SAC fabrication to fully understand, control and optimize the synthetic process and products obtained. One major challenge of SAC synthesis is the difficulty in controlling surface chemistry.[2] Electrodeposition provides a potential solution to this challenge since it allows for controlled deposition potential and time during the synthesis. For example, Zang and co-workers used anodic and cathodic deposition methods to synthesize A-$Ir_1/Co(OH)_2$ and C-$Ir_1/Co(OH)_2$, respectively. The deposition of well-separated single metal atoms onto the support surface occurred by varying the scan rates and scan cycles.[3] This approach proved to be reproducible and flexible as it is amenable to different support materials and precursor metals.[3] In another example, Xu and co-workers reported the use of cathodic corrosion as a method for synthesizing SACs. After first depositing platinum nanoparticles on N-doped carbon paper, referred to as Pt-NPs/NCP, the material was transformed into single Pt atom catalysts, referred to as Pt_1/NCP, by cathodic corrosion at a potential of -8V for 10 mins.[4] In a third example, Xia and co-workers used underpotential deposition (UPD) as method to synthesize ADMCs on transition metal dichalcogenides (TMDs), such as MoS_2. The first step was the deposition of Cu on the support to form Cu-SA/MoS_2, then by galvanic replacement, Pt displaced Cu to form the Pt_1-SA/MoS_2, where "SA" stands for single atom.[5] Most research groups use similar characterization methods to ascertain the identity and coordination environment of the SACs formed, including High-angle Annular Dark Field Scanning Transmission Electron Microscopy (HAADF-STEM), Energy-dispersive X-ray elemental mapping, and Extended X-ray Absorption Fine Structure (EXAFS). Researchers tested the activity of these SACs compared to commercial catalysts for the hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) and the SACs showed high activities in each case. All three papers showed that surface attachment isn't a problem when employing electrochemical methods thus, research on SACs can move forward on application studies.

References

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