Carbon nanotubes as promising materials to design a new class of high-performance electrocatalysts

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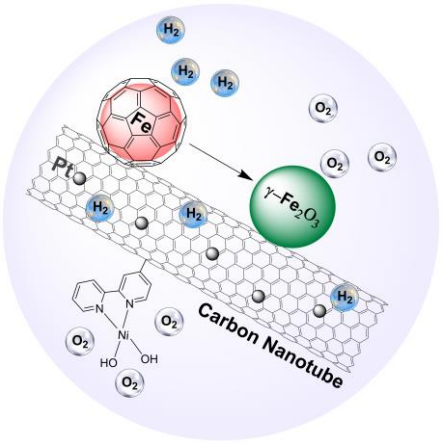
The development of efficient and low-cost electrocatalysts in electrocatalytic reactions plays an essential role because the catalyst determines not only the overall reaction efficiency but also the cost. We have developed a few synthesis methods to synthesize novel and low-cost electrocatalysts developed by carbon nanotubes (CNTs). CNTs are known for their exceptional properties in various applications. Here, I will further show that CNTs can be also utilized to create highly active and durable electrocatalysts [1-5]. In this talk, the focus is to design active catalysts for electrochemical water splitting by which highly pure hydrogen (as a clean energy carrier) and oxygen are produced from water. However, a new class of highly active and cost-effective electocatalysts presenting in this talk can be also utilized in other electrochemical energy devices.

We have developed a one-step chemical vapor deposition synthesis process to grow carbon-encapsulated iron nanoparticles (CEINs) supported on CNTs, as afficient electrocatalysts for catalyzing hydrogen production through electrochemical hydrogen evolution reaction [1]. The structure of CEINs can be also electrochemicaly modified to make them active for catalyzing another half-reaction in water electrolysis devices which is oxygen evolution reaction [2].

I further introduce single-walled CNTs (SWNTs) as promising supports to stabilize individual atoms or subnano clusters of Pt in order to produce much cheaper Pt catalysts with almost a similar activity to that of bulk Pt for electrochemical hydrogen production. I show how Pt atoms can be strongly immobilized on pristine small diameter SWNTs, suggesting SWNTs as promising candidates for the synthesis of single-atom catalysts [3].

Finally, I remark the promising performance of multi-walled CNTs (MWNTs) for the covalent functionalization with organometallic compounds to produce stable materials for catalyzing reactions occurring under harsh oxidizing conditions. I show how MWNTs can be utilized to immobilize organometallic Ni complexes, in order to significantly improve their electrocatalytic activity toward oxygen evolution reaction as a critical reaction limiting the efficiency of water splitting devices [4].



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