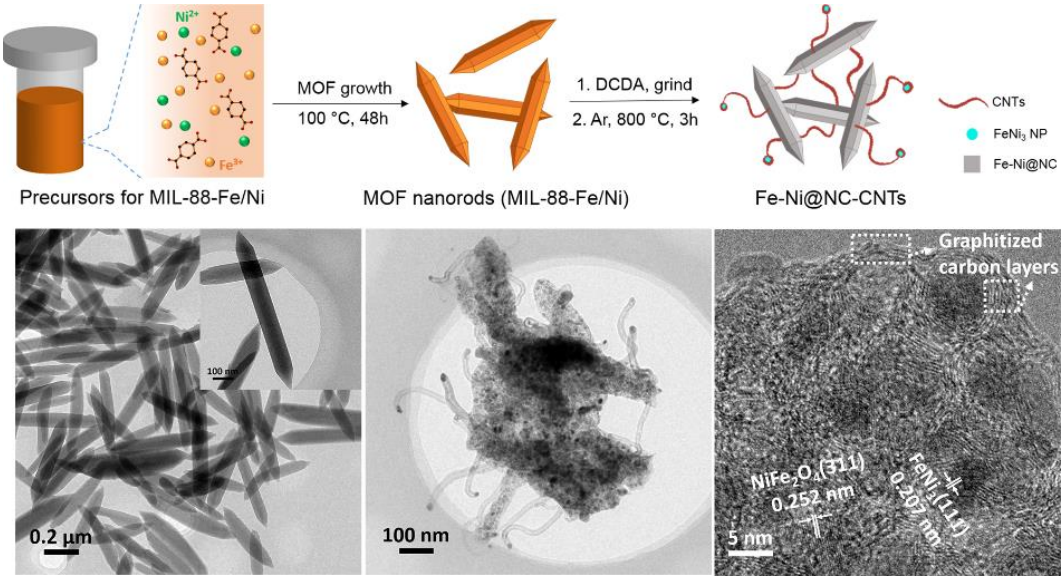
**TEM monitoring of newly modified MOF structures for OER and HER**

Simke, J.[1] and Zhao, X.[2]

[1] Technische Universität Berlin, Germany, [2] Technische Universität Berlin, China

Newly developed metal organic frameworks (MOFs) and its derived carbons as bifunctional electrocatalysts with high efficiency and durability for both, the oxygen evolution reaction (OER) and hydrogen evolution reaction (HER), are highly interesting candidates for achieving total water splitting alternatively to noble metal catalysts.[1] In this study, the conventional transmission electron microscopy (TEM), Tecnai G2 TEM @200kV equipped with EDAX R-TEM super ultra thin window, was operated to observe the morphology of the obtained electrocatalyst derived from bimetallic MOF (MIL-88-Fe/Ni). Selected area electron diffraction (SAED) was additionally used to determine the elemental composition and support the structural analysis. In order to guarantee excellent examination conditions for the catalysts, specially self-made carbon-hole films made from chloroform-dissolved formvar with glycerine and steam, with holes in sub micron range were used to guarantee the observation of whole particles without background. Accordingly, the as-synthesized Fe-Ni@NC-CNTs preserve the rod-shaped morphology of MIL-88-Fe/Ni, and these nanorods, threaded in a CNT network, consist of a carbonaceous matrix with embedded metal or metal oxide nanoparticles with diameters between 10-20 nm. High-resolution TEM (HR-TEM) and SAED further confirm the elemental composition, where the cubic $FeNi_3$ nanoparticles present at the tips of CNTs and the mixed phases of $FeNi_3$ and $NiFe_2O_4$ is observed in nanorod structures. Rationally, the excellent performance of Fe-Ni@NC-CNTs both for hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) can be attributed to, on one hand, the interlaced CNTs forming a highly conductive framework for rapid charge and mass transfer, on the other hand, the spinel structure of $NiFe_2O_4$ with multi-oxygen vacancies perform the synergistic effect with $FeNi_3$ nanoparticles to produce more active sites for electrocatalysis reaction.




Reference

[1] Xia, B.Y., et al., A metal-organic framework-derived bifunctional oxygen electrocatalyst. Nature Energy, 2016. 1.