

Chromium-ruthenium oxide solid solution electrocatalyst for highly efficient oxygen evolution reaction in acidic media

With the support of the National Natural Science Foundation of China and the aided program for Science and Technology Innovative Research Team of Ningbo Municipality, the research team led by Prof. Chen Liang (陈亮) at Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences, reported a chromium-ruthenium oxide solid solution electrocatalyst for the highly efficient oxygen evolution reaction (OER) in acidic media, which was published in *Nature Communications* (2019, 10: 162)

The development of active, acid-stable and low-cost electrocatalysts for the oxygen evolution reaction is urgent and challenging. In the present work, an Iridium-free and low ruthenium-content oxide material ($\text{Cr}_{0.6}\text{Ru}_{0.4}\text{O}_2$) was prepared based on the metal-organic framework with remarkable oxygen evolution reaction performance in the acidic condition. It showed a record low overpotential of 178 mV at 10 mA cm^{-2} and maintained the excellent performance throughout the 10 h chronopotentiometry test at a constant current of 10 mA cm^{-2} in $0.5\text{ M H}_2\text{SO}_4$ solution. Compared with pure RuO_2 , the drastically enhanced stability is related to the lower occupation at the Fermi level, while the higher activity results from the altered electronic structures. The calculated free energy diagrams for OER further demonstrate a lower energy barrier for the formation of $\ast\text{OOH}$, which is the rate determining step (RDS). On the other hand, Ru plays a key role in inducing the formation of rutile-structured CrO_2 and thus $\text{CrO}_2\text{-RuO}_2$ solid solutions because RuO_2 and CrO_2 share the same rutile structure and have similar lattice constants. These findings and results open a route to design highly active, stable and relatively low-cost electrocatalysts for OER in acidic media. To shed light on the further optimization, they investigated and screened a series of possible rutile-like $\text{MO}_2\text{-RuO}_2$ systems, in which M is a tetravalent cation. In light of the altered electronic structures in $\text{CrO}_2\text{-RuO}_2$, it was proposed that the electron withdrawing on Ru ions can facilitate water oxidation and oxygen evolution.

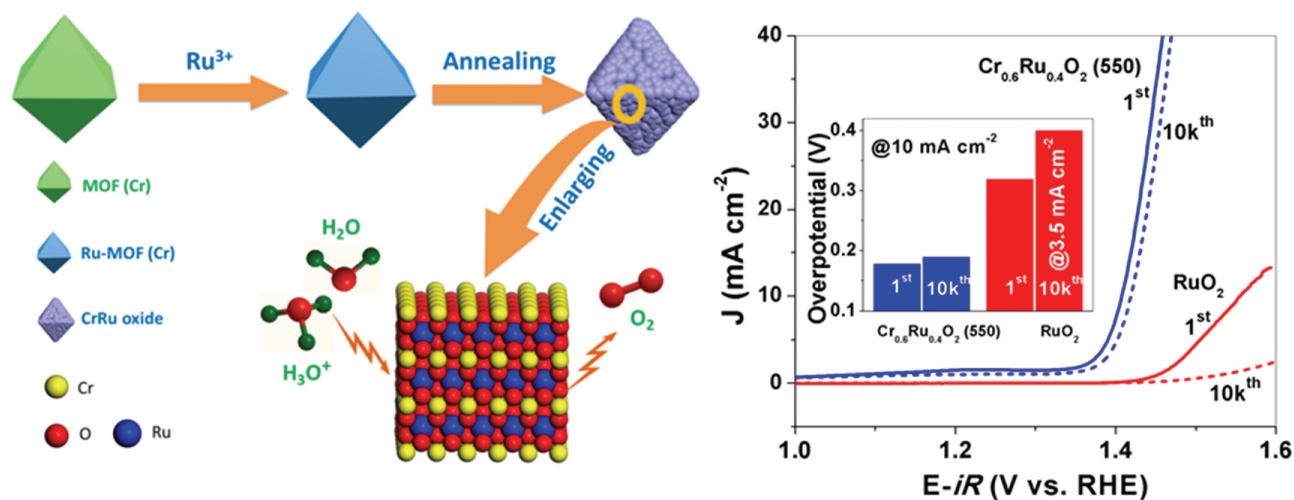


Figure Schematic illustration of the preparation of the $\text{CrO}_2\text{-RuO}_2$ solid solution and the corresponding OER activity.