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Ruthenium-Based Pyrochlore Oxides for Improved Electrocatalysis

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Energy security during the transition to a low-carbon economy is one of society's grand challenges. One possible method of developing carbon-neutral energy generation is through the combustion of hydrogen and oxygen gas. However, these gases must be able to be sustainably sourced using low-emission technologies.

One such method is using electrocatalysts – catalysts capable of splitting water into hydrogen and oxygen gas in the presence of electricity. Currently, industry standard electrocatalysts contain a high noble metal content, such as ruthenium and iridium. These metals are extremely expensive and their performance can degrade over time. Recently, pyrochlore oxides have emerged as promising alternatives due to their low noble metal content, extreme stability, and high oxygen evolution activity in acidic environments. However, despite this, debate currently exists in the literature as to what specific structural properties of these materials lead to their superior electrocatalytic performance.

This work presents full structural models of various ruthenium pyrochlore oxides of the form $(Y_{2-x}M_x)Ru_2O_{7-d}$ (M = Mn-Zn) based on various diffraction and spectroscopic studies. X-ray and neutron diffraction, as well as X-ray absorption spectroscopy, have been used to determine the short-range local and long-range average structures of these electrocatalysts. Cyclic voltammetry measurements have further shown significant oxygen evolution reaction activity compared to industry-standard ruthenium oxide, despite containing substantially less ruthenium. This has allowed us to establish structure-functionality relationships for these electrocatalysts, further developing and improving them for overall water splitting reactions.

Level of Expertise

Student

Presenter Gender

Man

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Which facility did you use for your research

Australian Synchrotron

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Yes

Do you wish to take part in the Student Poster Slam

Yes

Condition of submission

Yes

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