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Polymeric Binuclear Ruthenium Complex as Efficient Electrocatalyst for Oxygen Evolution Reaction

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Abstract:

A robust polymeric material constituted by chains of binuclear aqua ruthenium terpyridylphenanthroline complexes connected through benzene ring meta-positions, exhibiting an unusual two electrons and two protons PCET (proton-coupled electron transfer) process and enhanced oxygen evolution reaction (OER) activity, is described. The catalytic active $[\text{Ru}^{\text{V}}=\text{O}]$ species is generated at potentials more positive than +1.5 V (NHE) in the poly- $[\{\text{Ru}(\text{H}_2\text{O})(\text{phen})\}_2(\text{tpy}_2\text{ph})]$ film, as confirmed by the rise of the ruthenyl ($\text{Ru}^{\text{V}}=\text{O}$) stretching band at 810 cm^{-1} in the Raman spectrum, and the clear change to a higher activity regime as confirmed by EIS. Faradaic efficiency for OER as high as 39% was achieved at +1.8 V, indicating that poly- $[\{\text{Ru}(\text{H}_2\text{O})(\text{phen})\}_2(\text{tpy}_2\text{ph})]$ is one of the most active ruthenium terpyridine complexes ever prepared. The synthesis and characterization of the monomeric binuclear $[\{\text{RuCl}(\text{Clphen})\}_2(\text{tpy}_2\text{ph})]^{2+}$ and its respective $[\{\text{Ru}(\text{H}_2\text{O})(\text{Clphen})\}_2(\text{tpy}_2\text{ph})]^{4+}$ aqua complex are also fully described.

Keywords: Oxygen evolution reaction, ruthenium complex, binuclear catalyst, high valence complex, electrocatalysis, modified electrodes

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