Exploring noble metal modifications: enhanced electrocatalytic activity of cobalt and nickel electrodes in alkaline environments

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This research focuses on the development and comprehensive analysis of novel electrocatalysts for energy conversion applications, particularly for the hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) in alkaline media.[1,2,3] We investigated the electrocatalytic activity of nickel and cobalt electrodes modified with noble metals such as rhodium, ruthenium, iridium, and platinum. Modified polycrystalline electrodes were prepared via facile galvanic displacement from a highly concentrated acidic solution of noble metals.[1,2,3] Our findings show that nickel-based electrodes, especially those modified with rhodium and platinum, demonstrate superior performance, making them promising candidates for alkaline water electrolysis.[1,2] Because of its high efficiency, we investigated further the rhodium-modified nickel polycrystalline electrodes.[1] This surface modification led to a significant enhancement in both HER and OER activities, although hydrogen oxidation (HOR) and oxygen reduction reaction (ORR) activities were reduced compared to those of polycrystalline platinum. The presence of semiconducting Rh_2O_3 was found to adversely affect HOR and ORR performance, while metallic Rh and conductive RhO_2 were beneficial for the HER and OER.[1] The research further elucidates the mechanisms underlying the enhanced electrode kinetics on these Rh-modified nickel electrodes and highlights the role of rapid galvanic changes in improving electrocatalytic activity. Overall, the studies provide insights into engineering advanced, efficient, and cost-effective electrocatalysts for clean energy applications, critical for achieving energy security in modern society.

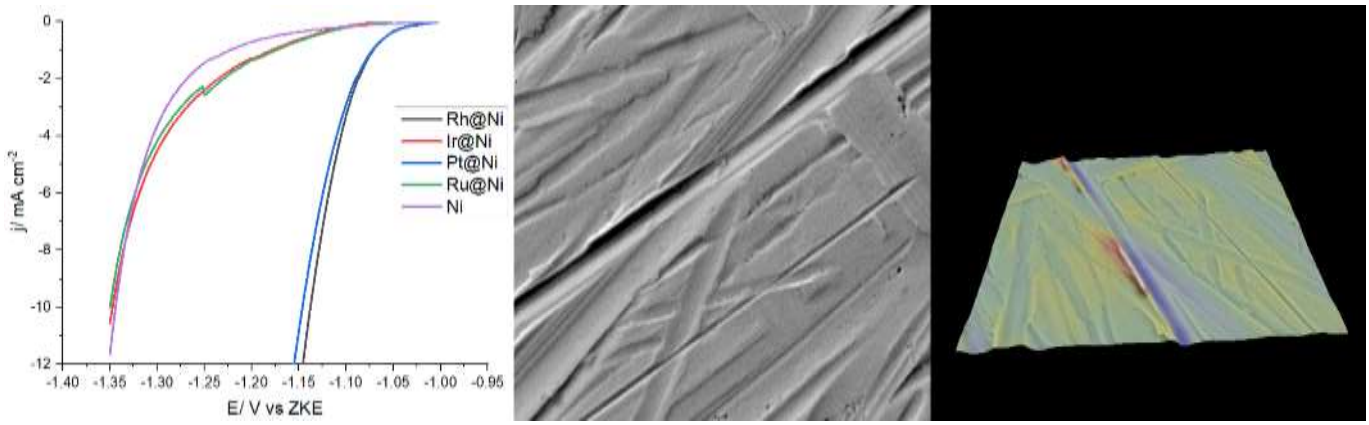

Figure 1. HER diagrams and scanning electron microscopy images

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References

1. L. Vasić, N. Tričković, Z. Bošković, A. Z. Jovanović, N. V. Skorodumova, S. V. Mentus, I. A. Pašti, Electrocatalysis of hydrogen and oxygen electrode reactions in alkaline media by Rh-modified polycrystalline Ni electrode. *ChemRxiv* (2023) https://doi.org/10.26434/chemrxiv-2023-0p036
2. A. Z. Jović, L. Bijelić, A. S. Dorbota, N. V. Skorodumova, S. V. Mentus, I. A. Pašti, Enhancement of hydrogen evolution reaction kinetics in alkaline media by fast galvanic displacement of nickel with rhodium – from smooth surfaces to electrodeposited nickel foams, *Electrochimica Acta*, **414** (2022) 140214 https://doi.org/10.1016/j.electacta.2022.140214
3. B. Nedić Vasiljević, A. Z. Jovanović, S. V. MentusN. V. Skorodumova, I. A. Pašti, Galvanic displacement of Co with Rh boosts hydrogen and oxygen evolution reactions in alkaline media, *J Solid State Electrochem.* **27** (2023) 1877-1887 https://doi.org/10.1007/s10008-023-05374-4