# Applying Magnetic Fields and Lewis Acids for a Highly Efficient and Cost-Effective Hydrogen Production From Seawater

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Green hydrogen is a renewable fuel and is considered one of the most promising alternatives to fossil fuels; however, commercialized production is hampered due to the high production cost and the usage of scarce freshwater sources. Seawater presents an abundant, largely untapped resource for hydrogen production, but seawater electrolysis is limited by inefficiency and the production of toxic chlorine gas. To achieve efficient seawater electrolysis, a chloride-impermeable and highly efficient catalyst is needed to withstand the harsh conditions of seawater. This research introduces novel strategies that apply a magnetic field and a Lewis acid layer to enhance hydrogen production in seawater electrolysis and prevent chlorine gas production. The magnetic catalyst NiZnFe3O4 was synthesized via the co-precipitation method and coated with Cr2O3 as a Lewis acid layer. The Ni-foam substrate was then immersed in the magnetic catalyst via direct magnetic interaction. Performance increased significantly after applying the magnetic field, with current densities rising by over three times for the highly magnetic NiZnFe3O4-Cr2O3, achieving a current density of 14 mA/cm² at 1.4 V. Furthermore, the catalyst demonstrates a high stability of continuous seawater electrolysis for over 72 hours, with nearly zero chlorine gas evolution, as confirmed by titration tests. This proposed system is 130 times less expensive and 24% more efficient than RuO2 at 2 V and almost three times better than RuO2 at 1.4 V when applying a magnetic field. This innovative system is poised to unlock seawater as a viable source for hydrogen production in commercial electrolyzers near seasides, thus contributing to a more sustainable energy economy.