Efficient alkaline water electrolysis at high current densities via designing the metals-doped nickel sulfide nanorod arrays

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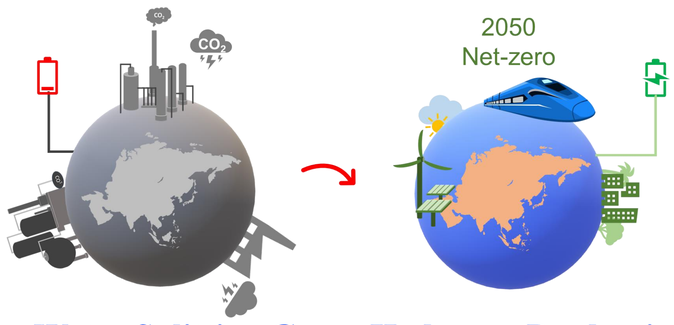
Introduction



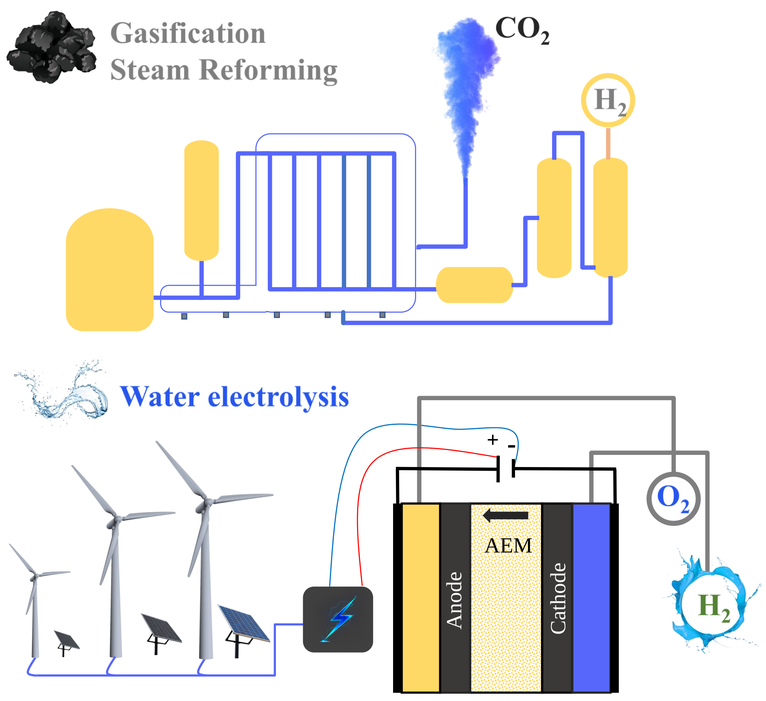
Water Splitting Green Hydrogen Production: Toward Net-Zero and Greener Future

Cathode: **Hydrogen Evolution Reaction (HER)**

$2H_2O + 2e^- \rightarrow 2OH^- + H_2$ $E^0 = 0.00$ V vs. RHE

Anode: **Oxygen Evolution Reaction (OER)**

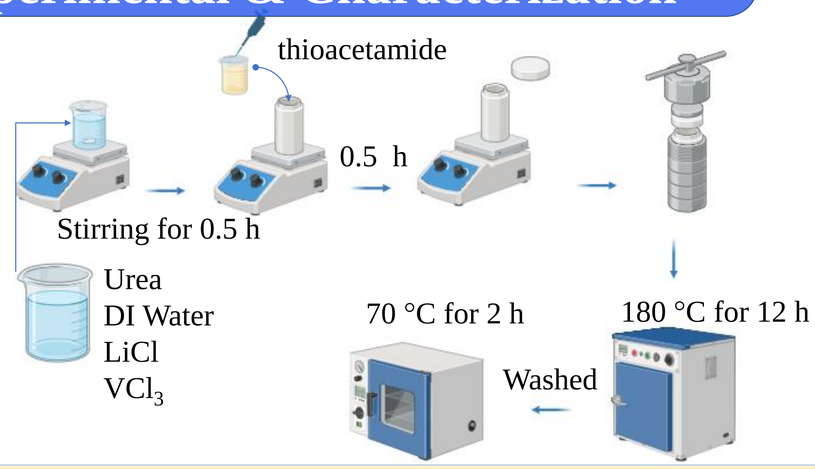
$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$ $E^0 = 1.23$ V vs. RHE



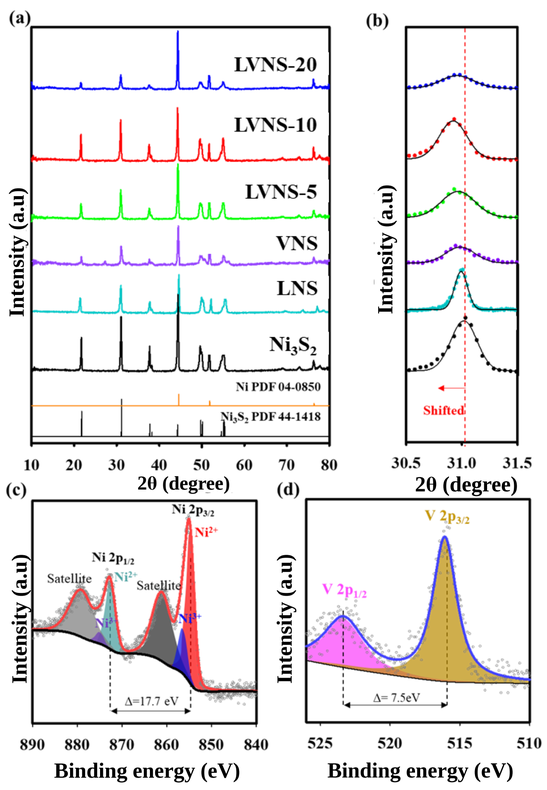
Research Highlights

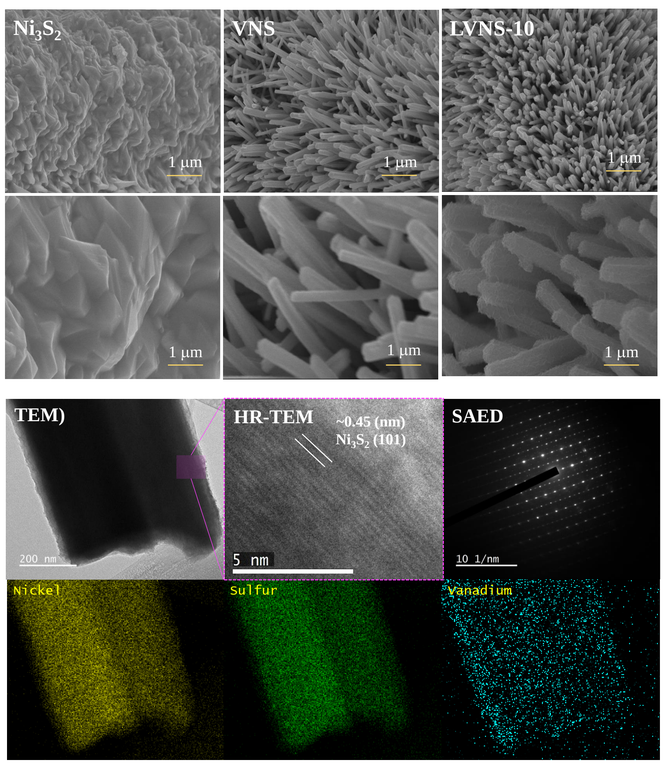
- Bifunctional **Li, V co-doped Ni_3S_2** catalysts were prepared by a hydrothermal method.
- Adding Li and V into the Ni_3S_2 enhanced **intrinsic activity** and **reaction kinetics.**
- Required low overpotentials of **298** and **−432 mV** for **OER and HER**, respectively, at a current density of **1000 mA/cm²**
- Single LVNS-10 stack cell of 2 × 2 cm² needed **1.92 V@500 mA/cm²** and **2.02 V@1000 mA/cm².**
- Our stack cell tested at 1000 mA/cm² or 4000 mA for 200 h exhibited **no degradation**.

Experimental & Characterization

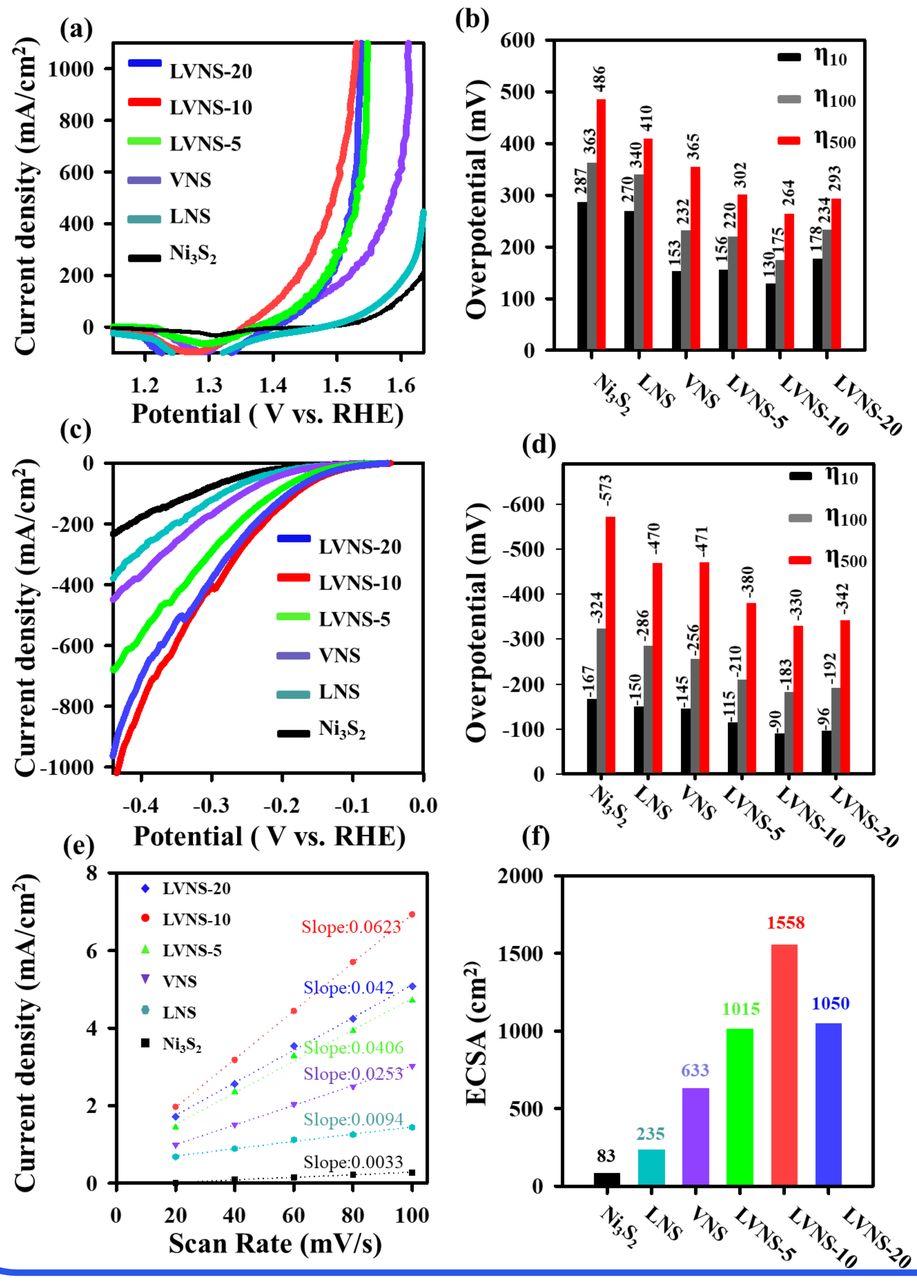


	Sample name	Molar ratio			
		LiCl	VCl_3	Urea	TAA
Pristine Ni_3S_2	Ni_3S_2	0	0	5	5
Li doped Ni_3S_2	LNS	1	0	5	5
V doped Ni_3S_2	VNS	0	0.1	5	5
V,Li-Ni_3S_2	LVNS-5	1	0.05	5	5
	LVNS-10	1	0.1	5	5
	LVNS-20	1	0.2	5	5

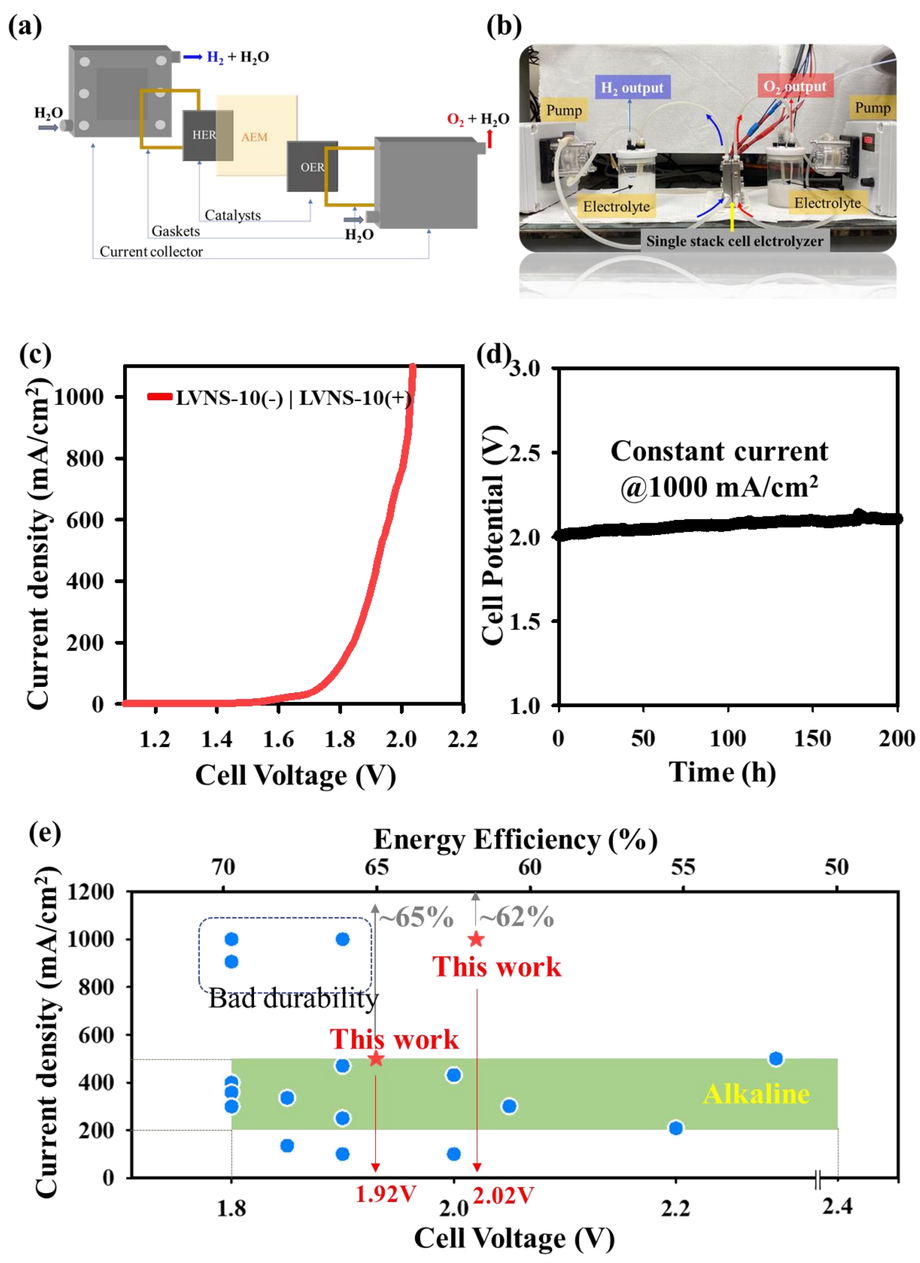


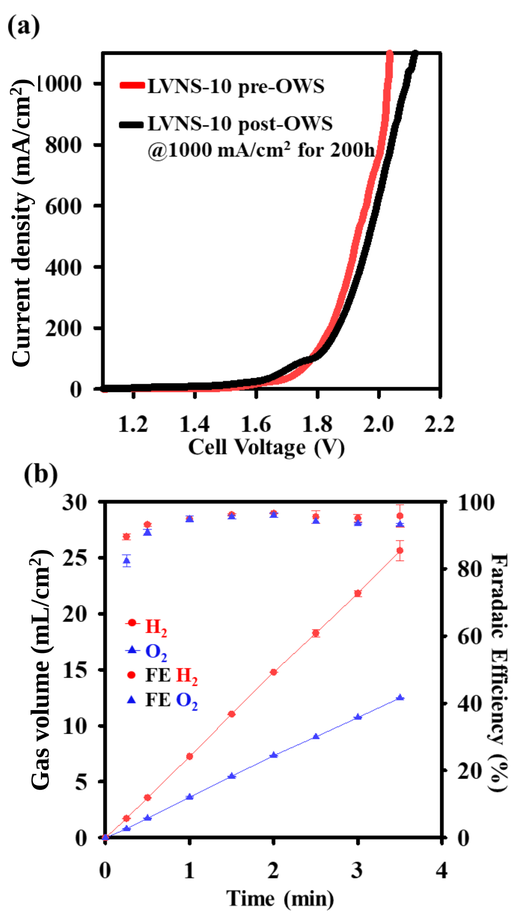


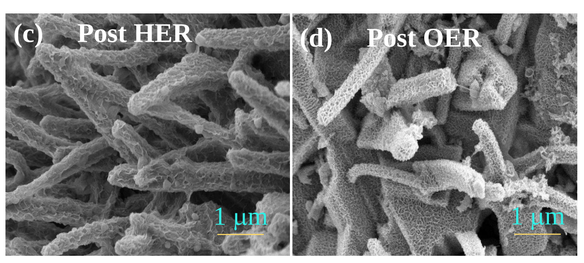
Electrolysis Performance



LVNS-10(+)||LVNS-10(+) electrolyzer (2 × 2 cm²) performance







Conclusion

We have developed a robust bifunctional electrocatalyst based on Ni_3S_2 with ultralow potentials even when operating at excessively high current densities to make water splitting more economically competitive for potential industrial applications. The introduction of Li, V could potentially modify surface properties of Ni_3S_2, leading to enhanced catalytic activity. With the optimal Li/V ratio of 1:0.1, our LVNS-10 catalyst exhibited excellent catalytic activity for overall water splitting, regardless of low or large current densities, with remarkable durability in an alkaline electrolyte.