

# Efficient Hydrogen Evolution by Nickel Phosphide Based Nanosheet Arrays Electrocatalyst

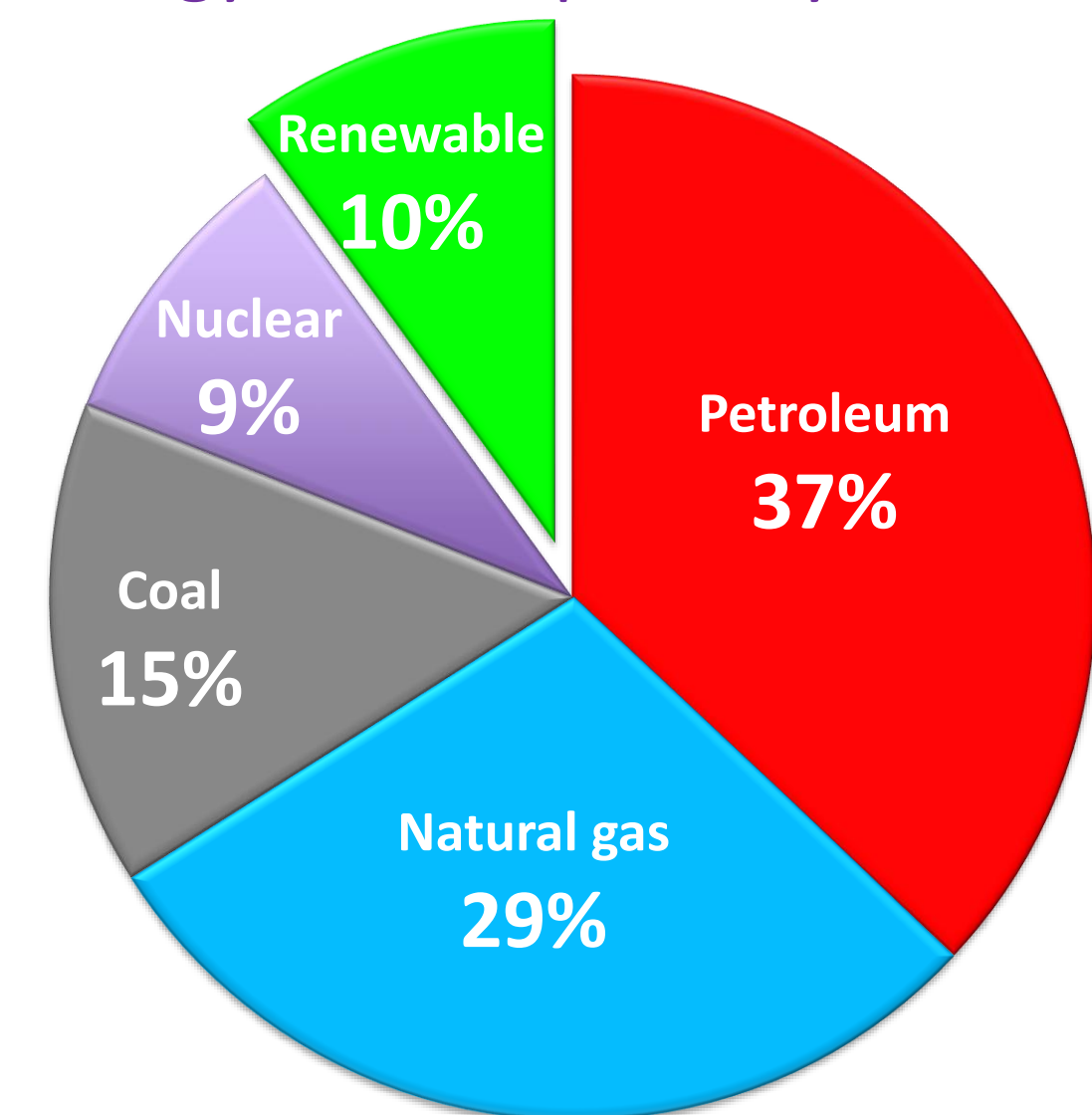
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## Background

Current primary energy supply is based on fossil fuels and nuclear sources. However, these sources are non-renewable and more importantly, their toxic byproducts cause severe environmental degradation.

U.S. Energy Consumption by Source, 2016



Source: U.S. Energy Information Administration



Pollution

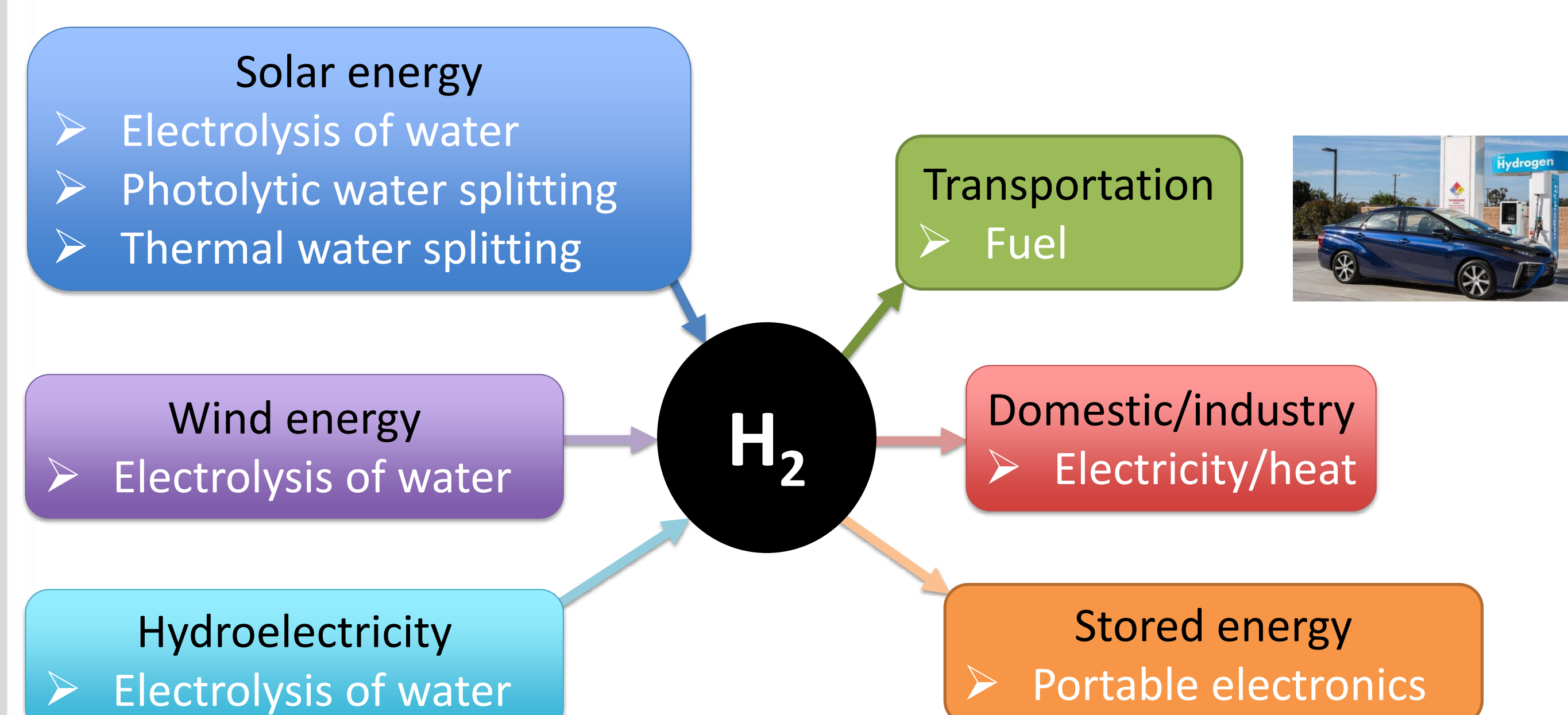
Environmentally friendly and feasible energy alternatives are in urgent demand.

## Hydrogen energy

Molecular hydrogen produced by water splitting is a potential energy carrier to fulfill the current energy demand.

Why hydrogen?

- Abundance of source
- Highest specific energy
- Renewable
- Non pollutant byproducts



## Methodology

Hydrogen from electrolysis of water  
 $2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$

Main limitation

- ❖ Very slow process

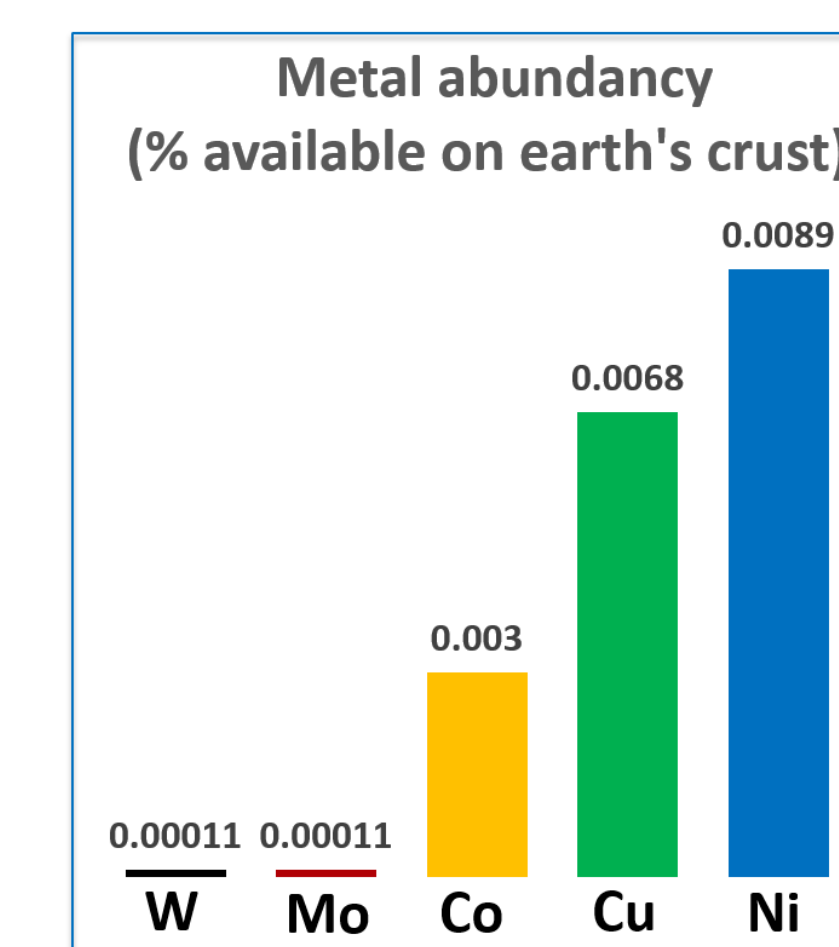
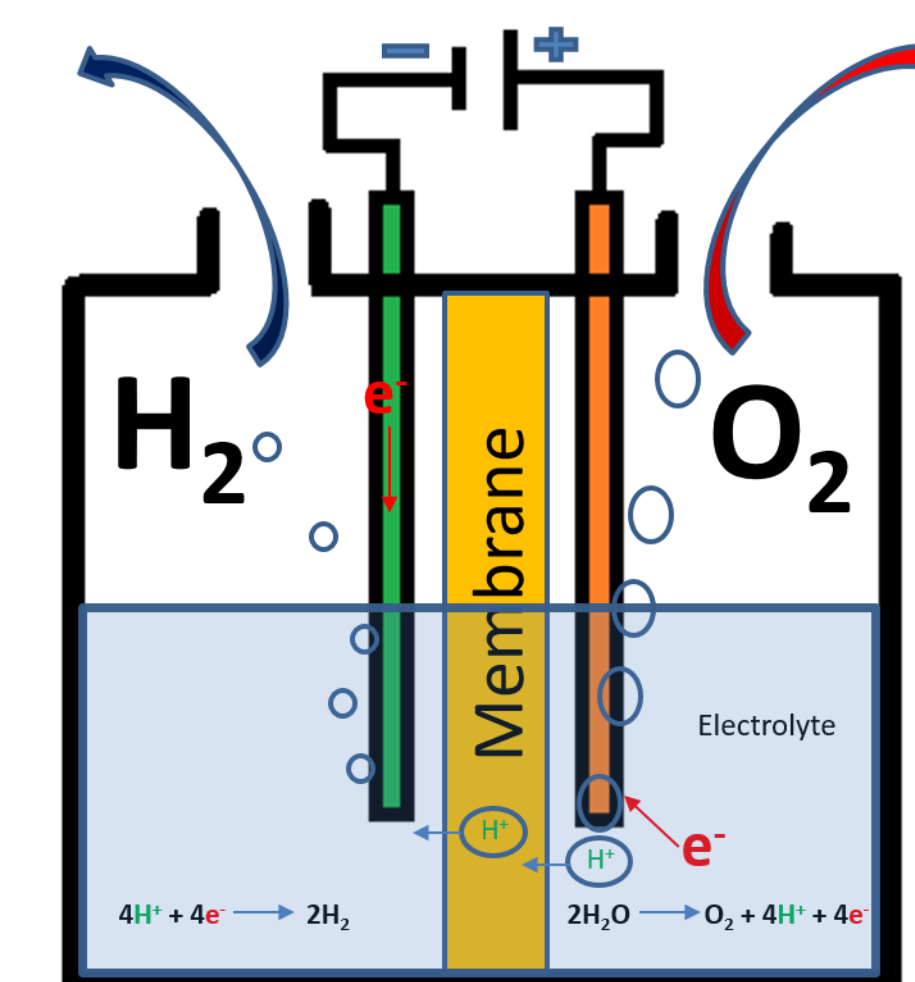
Solution

- Very active electrocatalyst is required to accelerate the reaction kinetics

Platinum is a very active electrocatalyst for electrolysis of water.

Hindrances of utilizing platinum

- ❖ Very expensive (about 1000 times more expensive than nickel)
- ❖ Limited amount on the earth's crust ( $3.7 \times 10^{-6} \%$ )

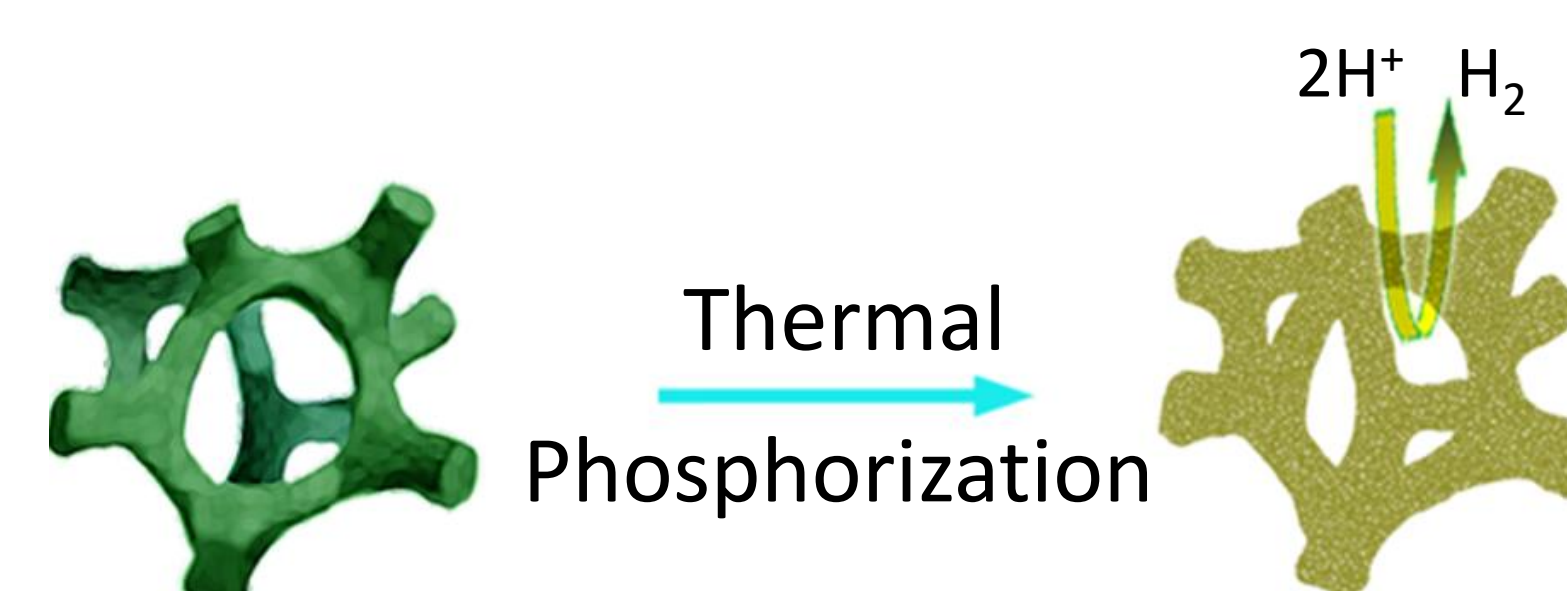
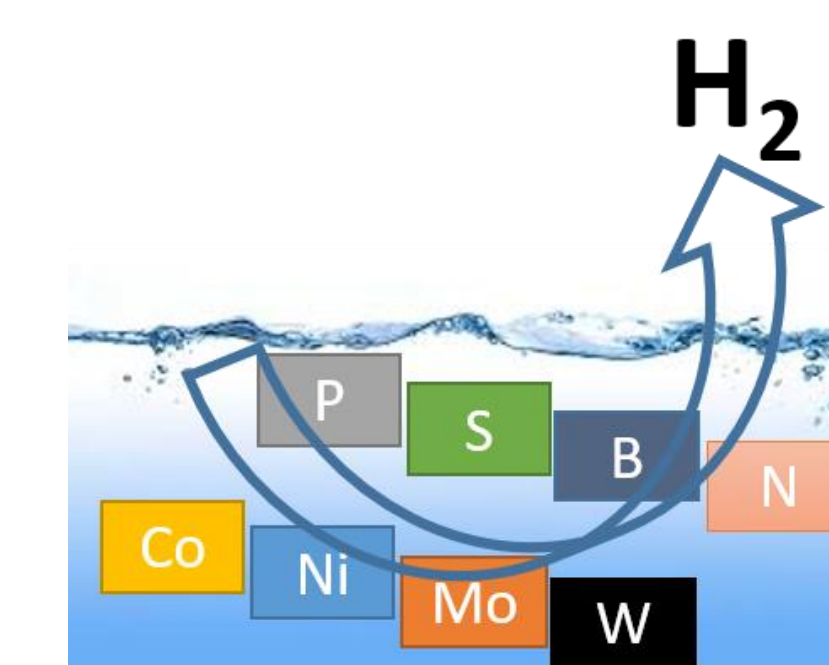


Any alternatives?

Highly active and stable electrocatalysts composed of earth abundant materials such as iron, nickel, copper, cobalt etc.

Nickel foam is a reliable starting material.

- Nickel is abundant on earth's crust
- Low cost and commercially available



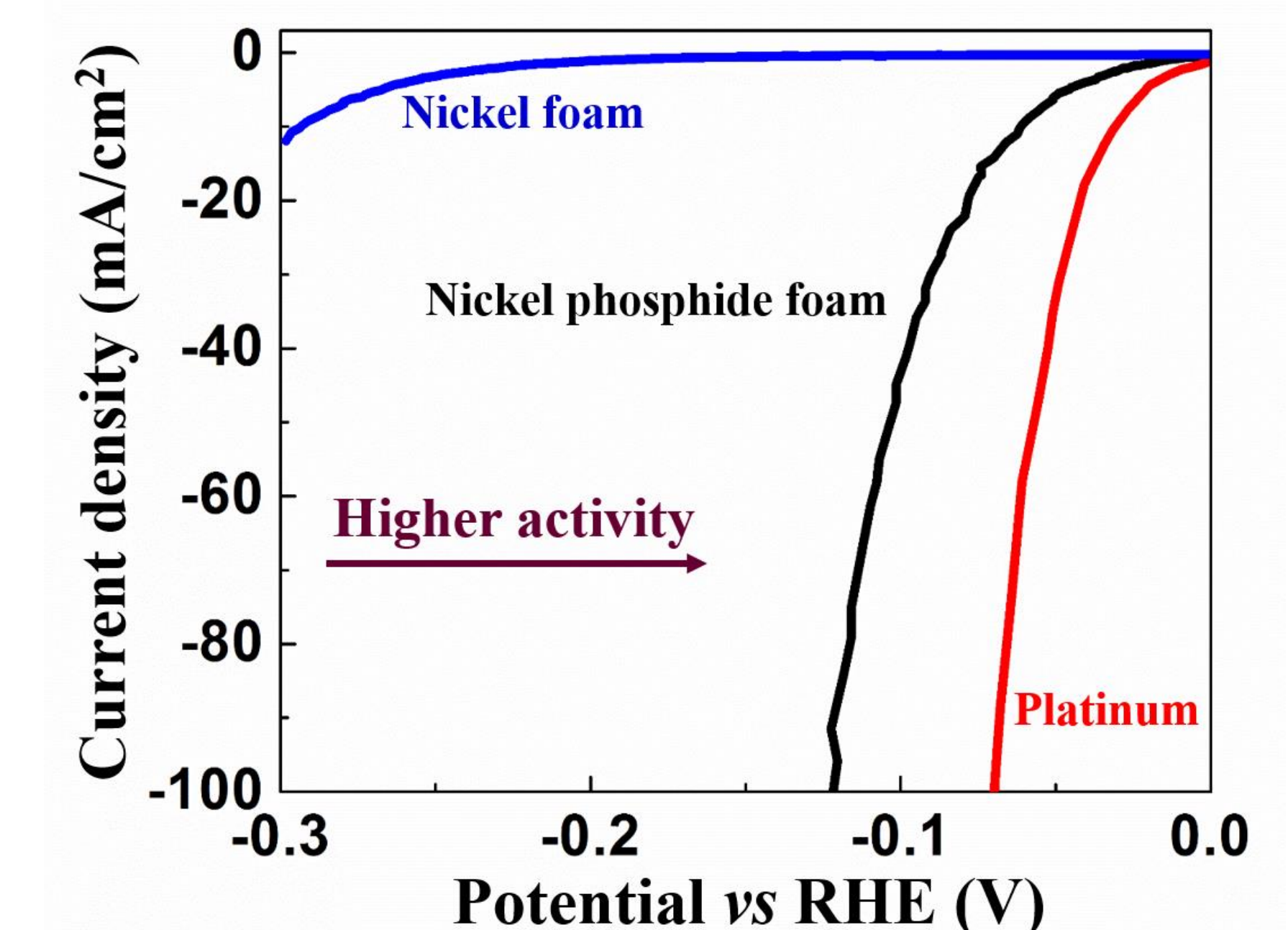
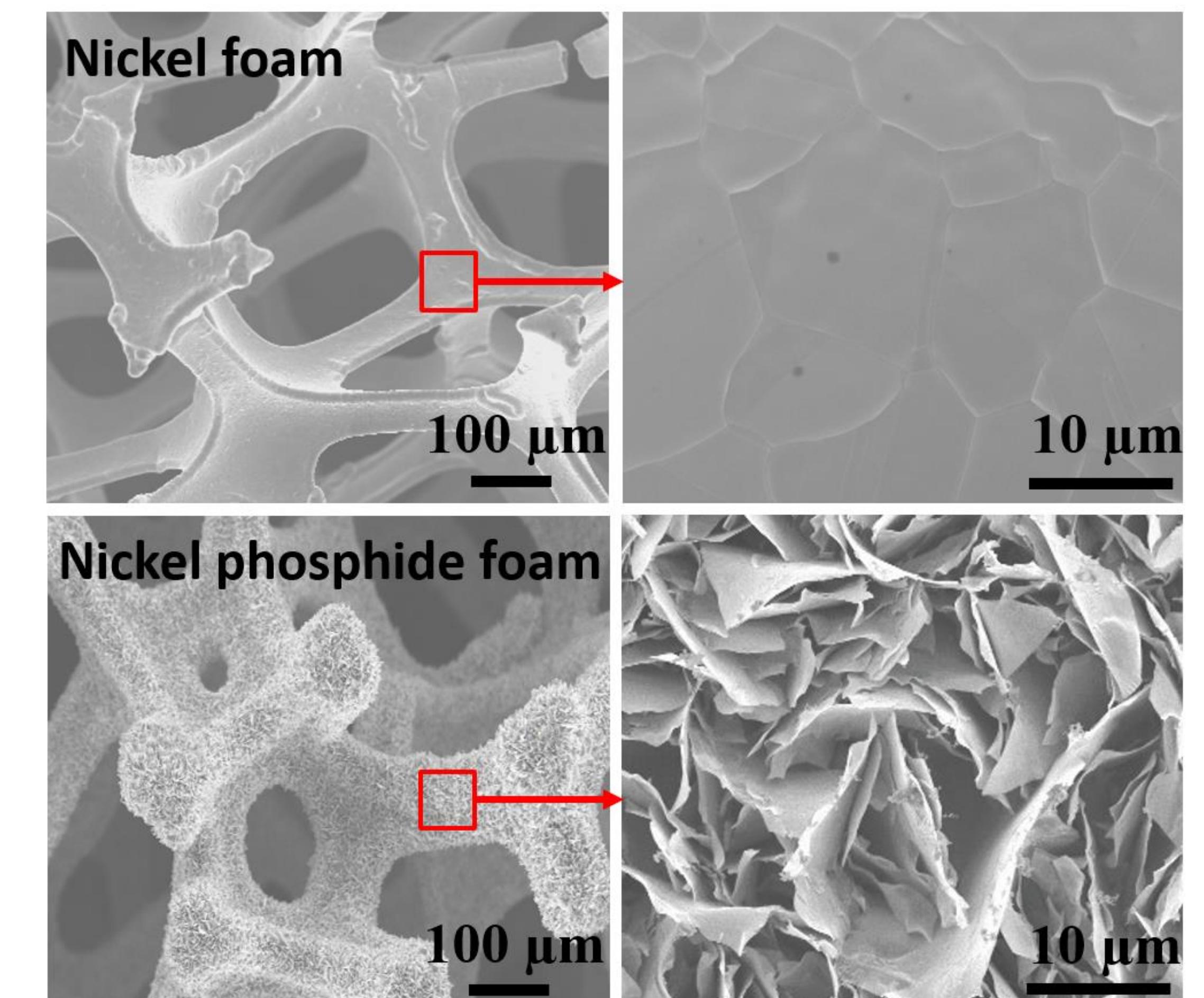
Nickel foam

- 3D
- Porous
- Not stable in acid
- Not active for hydrogen evolution

Nickel phosphide foam

- 3D
- Porous
- Stable in acid
- Highly active for hydrogen evolution

## Results



The self-supported nickel phosphide based nanosheet arrays electrocatalyst shows excellent hydrogen evolving efficiency requiring only 30 mV higher potential than that of platinum at benchmark current density of  $10 \text{ mA cm}^{-2}$  in  $0.5 \text{ M H}_2\text{SO}_4$ .

## Acknowledgements

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