Reducing the Amount of Critical Minerals on Graphene-Supported Electrocatalysts for Hydrogen Production

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Critical Minerals in the Clean Energy Transition

Critical minerals such as Co, Ni, Pt, and so on, are required in large quantities in a range of clean energy technologies, such as solar panels, batteries, and electrolysers which produce green hydrogen.1 For the production of hydrogen using an electrolyser, the state-of-the-art catalysts can contain up to 2 mg/cm² platinum. There is a need to reduce the amount of platinum required to decrease supply chain risks and electrolyser cost.2

Research Solution

To address this challenge, we used a carbon-based catalytic support, namely, edge rich vertically aligned graphene, which is cheap, scalable, and stable.3,4 We then deposited ultra-low concentrations of platinum onto the edge rich graphene, which are the active catalysts for electrochemical hydrogen production.5

Material Properties

Electron microscopy revealed that the platinum deposited was in single atom form, decorating the graphene edges. These single atoms are the sites where hydrogen is produced.6

Catalytic Properties

Amongst our materials, we found that platinum deposited on the graphene edge had significantly improved catalytic performance compared to platinum on the base of the graphene sheet.7 Compared to other state-of-the-art electrocatalysts, our material exhibited one of the highest intrinsic activities in hydrogen production.8

The Underlying Science

Using a combination of X-ray absorption spectroscopy and density functional theory calculations, we showed that platinum bound to the graphene edges exhibited a higher electron density near the Fermi level, which promoted efficient hydrogen production compared to platinum deposited on the basal plane of graphene.9

This research paves a pathway toward the design of high performing platinum catalysts, which can decrease the amount of platinum required in electrolyzers.

References

3Han, Z.; Tsounis, C.; Amal, R. US Patent App. 17/434,896, 2022