Researchers propose new method for electrocatalytic hydrogenation of acetylene to ethylene under room temperature

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Ethylene is one of the most important building blocks in chemical synthesis. Traditional thermocatalytic hydrogenation of acetylene to

ethylene (HAE) requires high temperatures and high pressure, leading to excessive energy consumption. Additionally, large amount of H_2 consumption makes this process even more costly.

Recently, a research group led by Prof. Deng Dehui from the Dalian Institute of Chemical Physics (DICP) of the Chinese Academy of Sciences (CAS) realized highly efficient electrocatalytic hydrogenation of acetylene to ethylene (E-HAE) under room temperature by directly using water as hydrogen source.

The study was published in *Nature Communications* on Dec. 6.

Compared with the thermocatalytic path, the new process developed by the researchers can directly take water as hydrogen source under ambient temperature and pressure, thereby avoiding the additional supply of hydrogen. In combination with renewable energy-based electricity, this process provides an environmentally-friendly, cheap, and efficient way for hydrogenation of acetylene to ethylene.

The researchers optimized the Cu catalyst to expose more active facets, facilitating preferential adsorption and hydrogenation of acetylene against hydrogen adsorption and evolution. By using a microporous gas diffusion layer to promote mass transfer, they achieved a high Faradaic efficiency of 83.2% for ethylene production.

In-situ spectroscopic characterizations combined with density functional theory calculations demonstrated that electron transfer from the Cu surface to adsorbed acetylene promoted the adsorption and hydrogenation of the acetylene, while suppressing the competitive hydrogen evolution reaction and facilitating ethylene desorption. This resulted in highly selective ethylene production via the electron-coupled proton transfer pathways.

"This process provides a green route for industrial production of C_2H_4 from C_2H_2 under mild conditions," said Prof. Deng.

More information: Suheng Wang et al, Highly efficient ethylene production via electrocatalytic hydrogenation of acetylene under mild conditions, *Nature Communications* (2021). DOI: 10.1038/s41467-021-27372-8

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