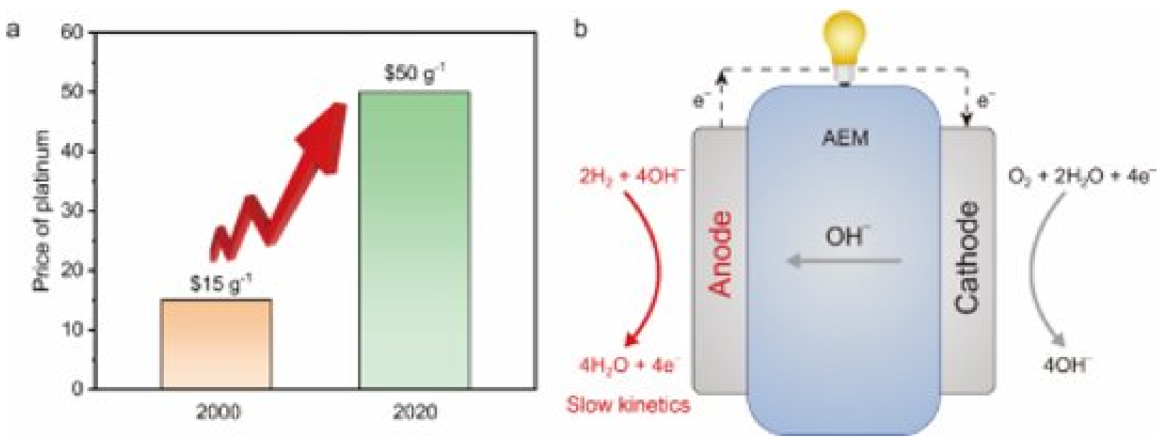
PHYS.ORG

Cheap alloy rivals expensive platinum to boost fuel cells

May 28 2021



The left figure shows platinum price trends over the past two decades and the right figure explains the alternative: anion exchange membrane fuel cells (AEMFCs). Credit: QIN Shuai et al.

As the cleanest renewable energy, hydrogen energy has attracted special attention in recent research. Yet the commercialization of traditional proton exchange membrane fuel cells (PEMFCs), which consume hydrogen and produce electricity, is seriously restricted due to the chemical reaction of PEMFCs cathode largely reliying on expensive platinum-based catalysts.

A solution is to change the acidic electrolyte of PEMFCs to alkaline. Such fuel cells are called anion exchange membrane fuel cells (AEMFCs), and they allow for the use of cheaper metal elements like

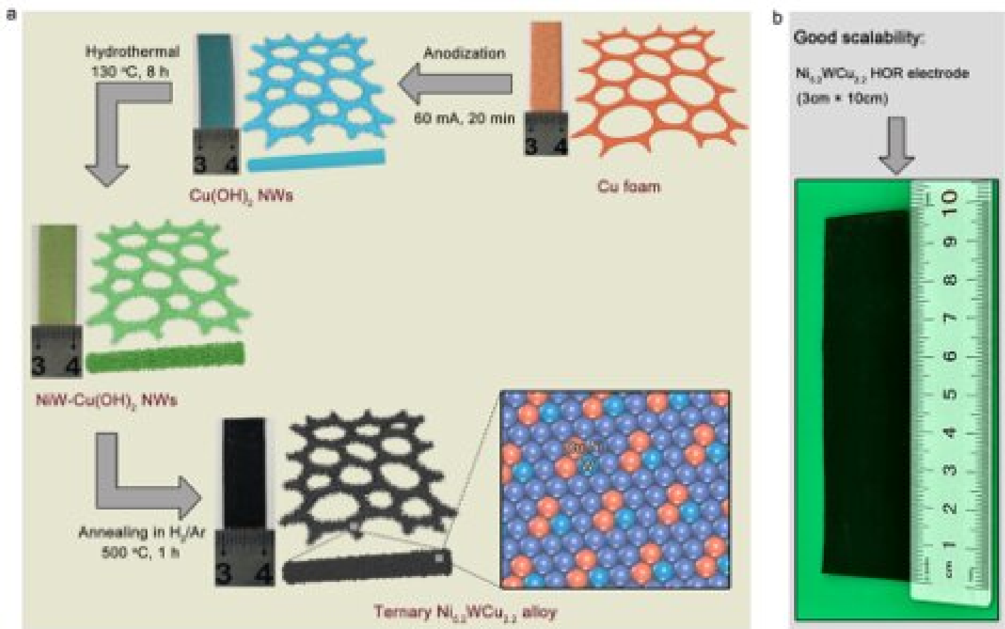
Co, Ni or Mn to design electrocatalysts.

The research team led by Prof. Gao Minrui from University of Science and Technology of China (USTC) followed this solution and developed a practical and scalable way to manufacture a novel Ni-W-Cu alloy, $Ni_{5.2}WCu_{2.2}$, as the cathode for AEMFCs. The result was published on *Nature Communications*.

The team first grew $Cu(OH)_2$ nanowires from a three-dimensional foam copper skeleton by anodic oxidation. The obtained nanowires were then immersed in a solution containing Ni and W elements. After hydrothermal synthesis and annealing, the Ni-W-Cu alloy was produced.

The ternary $Ni_{5.2}WCu_{2.2}$ alloy can catalyze the oxidation of hydrogen in alkaline medium 4.31 times more efficient than the benchmark platinum/carbon anode.

It has an oxidation potential as high as 0.3V in comparison with the reversible hydrogen electrode and can maintain high activity for up to 20h under such overpotential, proceeding anodes based on non-platinum-group metals.



Synthesis diagram of Ni5.2WCu2.2 and a Ni5.2WCu2.2 electrode of size 3×10cm2 obtained in this way. Credit: QIN Shuai et al.

The alloy catalyst also showed excellent resistance to CO poisoning, and maintained high activity in 20000 ppm CO/H_2 mixed atmosphere.

Analysis showed that the projected density of states of $Ni_{5.2}WCu_{2.2}$ alloy lies in the lowest Fermi level, which indicates that the alloy has the optimal hydrogen binding energy. The multiple-element alloying effect renders the Ni-based alloy a high activity catalyst and offers oxidation resistance.

This work sheds light on further exploration of multiple-element alloys composed of cheap metals, thereby aiding the development of more efficient hydrogen oxidation catalysts for AEMFC anodes.

More information: Shuai Qin et al, Ternary nickel–tungsten–copper alloy rivals platinum for catalyzing alkaline hydrogen oxidation, *Nature*

Communications (2021). DOI: 10.1038/s41467-021-22996-2

Provided by University of Science and Technology of China