advanced materials

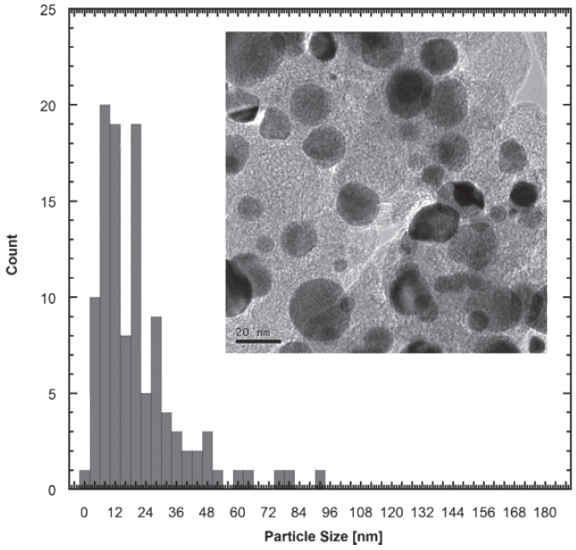
Palladium-Cobalt Nanoparticles for Oxygen Reduction Electrocatalysis

Summary

Platinum is the most efficient electrocatalyst for accelerating the oxygen reduction reaction in fuel cells, but it is both rare and expensive. These breakthrough palladium-cobalt nanoparticles successfully replace platinum in this crucial reaction, resulting in a highly effective, low-cost electrocatalyst.

Description

Ternary alloys of palladium, cobalt, and a third transition metal are formed into nanoparticles, bound to a conducting medium, and applied as the anode in a fuel cell to reduce oxygen. Palladium-cobalt alloys may also incorporate two additional transition metals, such as nickel and iron, to make a four-component, or quaternary, alloy. These alloys are deployed on the anode of fuel cells as electrocatalysts for the oxygen reduction reaction. Measurements of binary Pd_2Co catalysts on carbon supports give a Tafel slope for oxygen reduction of -80 mV/decade, compared to platinum's -90 mV/decade, while the half-wave potential of 0.84 V is similar to that of platinum. The palladium-cobalt alloys also display exceptional methanol tolerance, with the half-wave potential dropping only 20 mV in solutions containing 0.1 M methanol, suggesting its use in direct methanol fuel cells.



TEM image of carbon-supported palladium-cobalt alloy nanoparticles treated at 900 °C (inset), and particle size distribution in nanometers.and coating it with a monolayer of platinum to create the high mass activity catalyst.

Benefits

The palladium-cobalt nanoparticles have the same catalytic activity as the highly expensive platinum nanoparticles making them an attractive alternative to platinum. Wet chemical production methods are easy to rapidly implement, adapt, and scale up.

Applications and Industries

The nanoparticle electrocatalyst has been successfully tested for fuel cells, but in principle could be used to reduce oxygen in any context.

References

Shao, *et al.*, "Palladium Monolayer and Palladium Alloy Electrocatalysts for Oxygen Reduction," *Langmuir*, 2006, 22 (25), pp 10409–10415; DOI: 10.1021/la0610553; http://pubs.acs.org/doi/full/10.1021/la0610553

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