A new method for small-sized platinum intermetallic fuel cell catalysts

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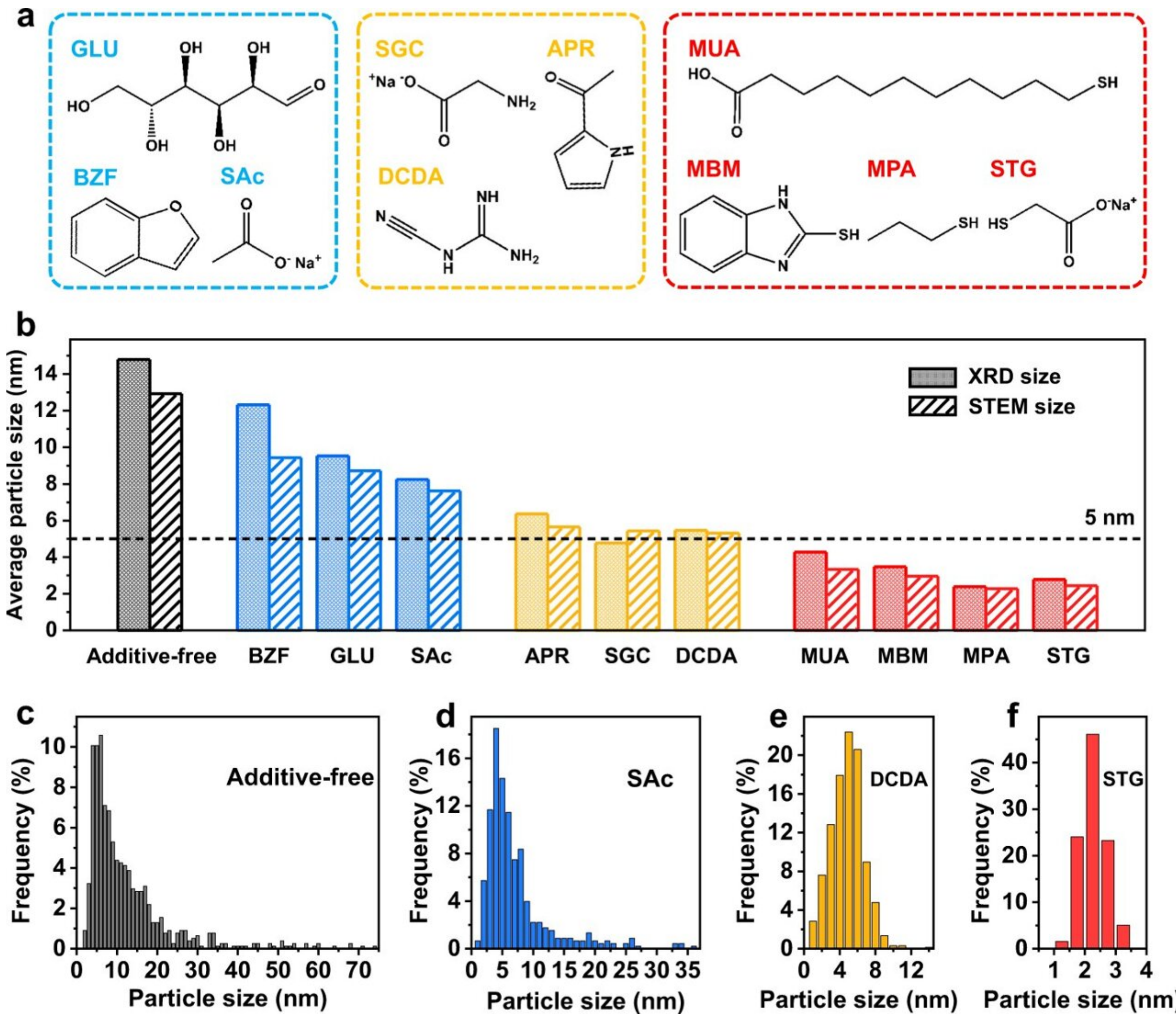

Screening small molecules for suppressing metal sintering. (a) The structures of the molecules used as additives for suppressing metal sintering. (b) XRD (solid shadow column) and STEM (twill stripes column) sizes of PtCo particles with various molecule additives used for the catalyst synthesis at 700 °C. STEM statistics of particle size distribution of PtCo synthesized without (c) and with three representative molecule additives, including SAc (d), DCDA (e), and STG (f). Credit: *Nature Communications* (2022). DOI: 10.1038/s41467-022-34037-7

Platinum plays a main role in fuel cell catalysts but restricts the commercialization of fuel cells due to its high cost. Given this limitation, scientists developed intermetallic compounds (IMCs) as a promising low-Pt electrocatalyst.

However, the synthesis of IMCs remains difficult because direct high-temperature annealing easily leads to alloy sintering, enlarging the nanoparticle and causing a decrease in Pt availability.

Recently, a research group led by Pro. Liang Haiwei from the University of Science and Technology (USTC) of the Chinese Academy of Sciences developed a small molecule-assisted impregnation approach to realizing the general synthesis of carbon-supported platinum intermetallic fuel cell catalysts. The study was published in *Nature Communications*.

Previously, Liang's team and collaborators realized sulfur-anchoring synthesis. However, the use of commercialized carbon black propelled the discovery one step closer to widespread application.

In the research, scientists first screened some small molecules containing heteroatoms as additives in the impregnation and suppressed PtCo sintering, taking the additive-free group as a control.

"Notably, sulfhydryl group-containing molecules…exhibited outstanding capacity for suppressing PtCo sintering," the researchers wrote in the paper, and water-soluble sodium thioglycolate (STG) stands out to be the optimal additive.

After that, the conditions of annealing were optimized to synthesize 18 binary Pt-IMCs catalysts with relatively small particle sizes, and the evidenced structure met expectations, featuring a uniformed distribution of nanoparticles, base metal elements, and atoms. Six synthesized catalysts were tested and showed excellent activity, capacity, and durability.

Why does STG work? STG, according to the study, coordinates with Pt and Co via a sulfhydryl group and a carboxylate group to form the precursors, which gradually decompose during annealing and form PtCo bimetallic clusters, releasing STG. The STG finally converts into a physical protective carbon coating and provides chemical Pt-S interaction with doped S to suppress PtCo sintering.

The research has also shed some light on the application of Pt intermetallic catalysts in other energy-conversion-related electrocatalysis and heterogeneous catalysis.

More information: Tian-Wei Song et al, Small molecule-assisted synthesis of carbon supported platinum intermetallic fuel cell catalysts, *Nature Communications* (2022). DOI: 10.1038/s41467-022-34037-7

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