

Pt and hollow PtCo nanoparticles supported on carbon xerogels for PEM fuel cell catalyst layers

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Proton Exchange Membrane Fuel Cell electrocatalysts are commonly made of Pt/carbon black nanoparticles about 3 nm in diameter [1]. However, Pt nanoparticles are not stable under operating conditions and the use of carbon black does not allow control of the electrode nanostructure while this feature is key to mass transport properties. In this work, nanostructured carbon xerogels (CX) were used to synthesize supported plain Pt (Fig. 1a) and hollow PtCo nanoparticles (Fig. 1b) since that type of support leads to better reactant diffusion within the pore texture [2]. The addition of Co leads to the Pt lattice contraction, and thus to much higher catalytic activity towards oxygen reduction reaction while the hollow structure allows for relatively good metal utilization ratio despite the large particle size. PtCo/CX catalysts with 10 wt.% Pt were prepared; residual Co content ranged from 0.3 to 4.6 wt.%.

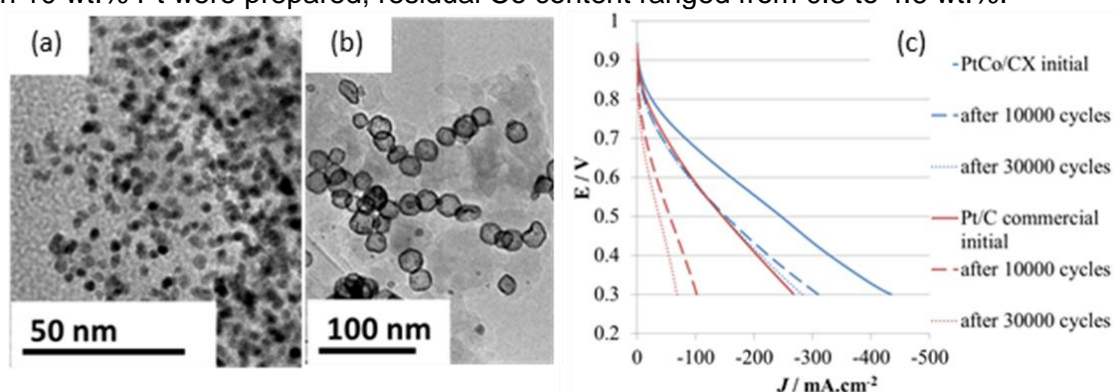


Figure 1: (a) TEM picture of a Pt/CX catalyst (40% wt.) prepared by impregnation-reduction process [3]. (b) TEM picture of hollow PtCo/CX nanoparticles [4]. (c) Comparison between commercial Pt/carbon black and hollow PtCo/CX catalysts at the cathode of a fuel cell (H_2/O_2); the Pt content is constant ($0.033 \text{ mg}_{Pt}/\text{cm}^2_{\text{electrode}}$), and cells were cycled up to 30,000 times between 0.6 and 1.0 V [4].

These catalysts were thoroughly characterized using physico-chemical and electrochemical techniques, including Accelerated Stress Tests (ASTs) in complete fuel cell configuration using a classical Pt/carbon black at the anode. ASTs consist in sharp voltage increase and decrease between 0.6 and 1.0 V to accelerate the catalyst ageing. Results show that the hollow PtCo/CX catalysts display much better stability than pure Pt/CX and Pt/carbon black samples. Indeed, while the performances of Pt nanoparticles continually decrease with ageing time, the current-voltage curves obtained with PtCo/CX hollow particles stabilize after a while. The reasons for enhanced stability probably lies in the large size and regular shape of the hollow nanoparticles.

References

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