Mesostructured Pt-Based Bimetallic Nanospheres Containing an Intermetallic Phase as Ultrastable Support-Free Electrocatalysts for Oxygen Reduction

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Developing highly active and stable cathode catalysts is of pivotal importance for proton exchange membrane fuel cells (PEMFCs). While Pt-based, carbon-supported nanocatalysts showed excellent oxygen reduction reaction (ORR) activities in rotating disk electrode (RDE) measurements [1,2], highly active catalysts have been reported sporadically in single-cell configuration [3], which has more practical relevance. In addition, considering the practical applicability of new ORR catalysts, the development of highly durable ORR catalysts capable of mitigating the dissolution of Pt and/or the corrosion of the carbon support is of critical importance.

In this presentation, we report self-supported mesostructured Pt-based bimetallic (Meso-PtM; M = Ni, Fe, Co, Cu) nanospheres containing an intermetallic phase, which can combine the beneficial effects of transition metals, an intermetallic phase, a 3D interconnected framework, and a mesoporous structure [4]. Meso-PtM nanospheres showed enhanced ORR activity, compared to Pt black and Pt/C catalysts. Notably, Meso-PtNi containing an intermetallic phase exhibited ultrahigh stability, showing enhanced ORR activity even after 50,000 potential cycles, whereas Pt black and Pt/C underwent dramatic degradation. Importantly, Meso-PtNi with an intermetallic phase also demonstrated superior activity and durability when used in a PEMFC single-cell, with record-high initial mass and specific activities.

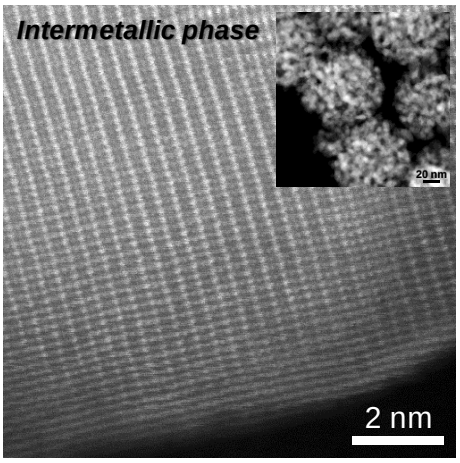

Fig.1 High-angle annular dark field scanning transmission electron microscopy (HAADF STEM) image of Meso-PtNi.

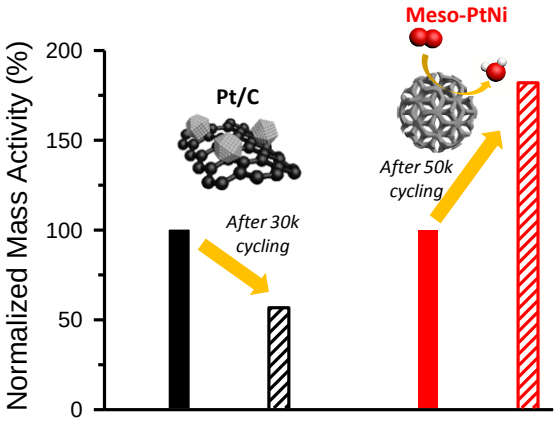

Fig.2 Normalized ORR mass activity of the Meso-PtNi and commercial Pt/C catalysts.

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