Advanced Fuel Cell Catalyst based on Graphene

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Polymer electrolyte membrane fuel cells (PEMFCs), which use hydrogen as the fuel and oxygen from the air to produce electricity, have attracted extensive interests over the past few decades. So far, commercial Pt/C cathodes for PEMFCs exhibit specific Pt loading of 0.5 g/kW, arising from loading-per-functioning area of 0.5 mg/cm^2. While such fuel cells exhibit a high-power density of 1W/cm^2, they can suffer from catalyst degradation, sluggish oxygen reduction reactions (ORR) with large overpotentials, and unsustainably large catalyst mass loading. What is needed is a material system that provides nanosized catalysts and be cost-effective and entirely compatible with large-scale industrial production. As members of the EU Graphene Flagship, Amalyst and the Commissariat à l'Énergie atomique (CEA) in Grenoble are collaborating in the development of a new generation of catalysts based on graphene and with higher durability. The CEA brings significant expertise in fuel cell material characterisation and Amalyst has an active programme in fuel cell catalyst development. As described Figure 1, electrochemical data shows typical platinum-like characteristics but most significantly, the degradation rate is much lower than for current platinum on carbon catalysts. The performances of our catalyst were also tested in MEAs, showing slightly higher performances than the reference TANAKA (TKK) catalyst (Figure 2). In collaboration with the CEA in Grenoble, the performances of our catalyst were also tested on a 1 kW fuel cell stacks. Degradation and stability catalysts would be discussed further at the conference.

Figures

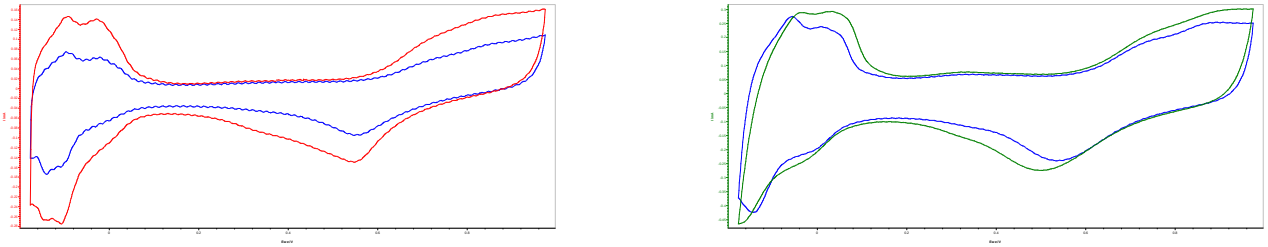

Figure 1: On the left, Platinum degradation observed on Johnson Matthey catalyst (40% Pt/C, CV before and after 7000 cycles). On the right, Platinum degradation observed on our graphene-based catalyst (40% Pt/G, CV before and after 7000 cycles).

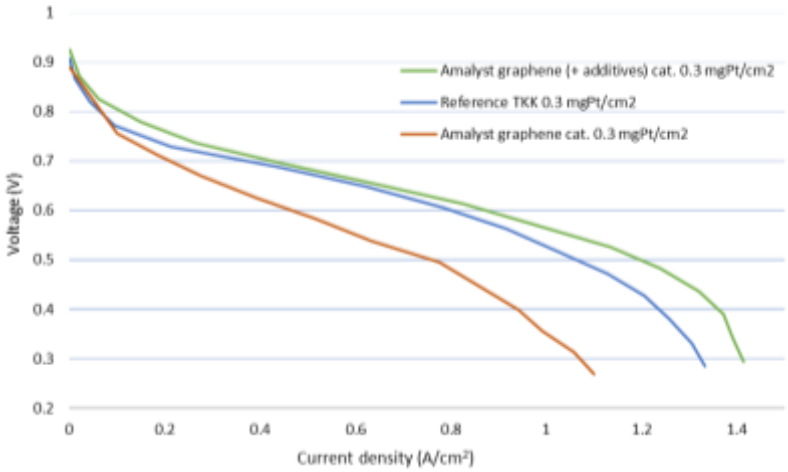

Figure 2: Polarisation curves of our graphene catalyst with and without additives (40% Pt/G) compared to the TKK reference catalyst (40% Pt/C).