Bimetallic catalysts supported on carbon xerogels for PEMFC cathode

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A fuel cell is an electrochemical device that converts the chemical energy of a fuel (e.g. hydrogen, methanol) directly into electrical energy following the principle is shown in Figure 1. The main advantages of fuel cells are: (i) they produce zero or very low emissions, especially greenhouse gases, (ii) they produce electrical energy with a very high yield (up to 60%), (iii) they can be used for combined heat and power purposes, further increasing the efficiency of energy production and (iv) they are entirely silent.

One of the types of fuel cell is Proton Exchange Membrane Fuel Cells (PEMFCs). They work at low temperature (< 100°C), uses a proton-exchange membrane, *i.e.* Nafion® as an electrolyte. The most frequent catalysts used in PEMFCs are platinum nanoparticles deposited on carbon (Pt/C). The major hurdle is stability: the platinum nanoparticles can dissolve, coalesce, grow, and the carbon support may oxidise, which leads to nanoparticle detachment, a decrease of electrochemically surface. Also, due to the sluggish Oxygen Reduction Reaction (ORR), large amounts of Pt are used, which makes the fuel cell manufacturing expensive. In the exploration of alternative catalysts, researchers have looked at several other types of materials, one of the ideas is to decrease the amount of needed precious metal by the partial substitution of Pt with potential candidates such as cobalt [1].

Among the various possible structures, hollow particles are considered. Hollow particles have void space in their body, are presently attracting great attention due to their unique properties such as high surface-to-volume ratio, and excellent chemical and thermal stabilities. They display higher activity and are more stable than usual Pt nanoparticles [2]. The PtCo alloys are much more active than pure Pt due to the strain-ligand effect on the Pt lattice obtained by introducing cobalt atoms. Synthesis of PtCo hollow nanoparticles on carbon xerogels was previously performed [2]. The obtained catalysts showed high activity and resistance to degradation. However, the synthesis method is complex, and the next step is to optimise the procedure and simplify it while reaching larger platinum loading (> 20 wt.%). Synthesised catalysts will be investigated by various physicochemical and electrochemical techniques.

a)

Anode: $H_2 \rightarrow 2H^+ + 2e$ (1)

Cathode: $\frac{1}{2}O_2 + 2H^+ + 2e \rightarrow H_2O$ (2)

Overall: $H_2 + \frac{1}{2}O_2 \rightarrow H_2O$ (3)

Figure 1 Summary reactions are occurring in PEMFC.

References

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