Iron- and nitrogen-doped carbide-derved carbon/carbon nanotube composites as electrocatalysts for acidic oxygen reduction reaction

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Fuel cell electric vehicles (FCEVs) fuelled by hydrogen are already available worldwide, however, their commercial success is hindered by issues with the fuel cell itself. Proton exchange membrane fuel cells (PEMFCs) used in FCEVs produce energy from hydrogen and oxygen from air, namely through hydrogen oxidation reaction and oxygen reduction reaction (ORR) occurring on the anode and cathode electrodes, respectively. Both of these reactions need electrocatalysts based on scarce and expensive noble metals, like Pt-group metals [1,2]. So, to meet the price and sustainability criteria, it is necessary to significantly reduce the content or to discard Pt-group metals entirely. For the cathodic ORR, transition metal and nitrogen-doped carbon (M-N-C) nanomaterials have shown the most promise as Pt-free alternatives [3,4].

Herein, three different methods are investigated for mixing iron (iron(II) acetate) and nitrogen (1,10-phenanthroline) precursors with nanocarbon support materials comprised of carbide-derived carbon (CDC) and carbon nanotubes (CNTs). Furthermore, the effect of acid leaching is studied. The results indicate that mixing via ball-milling is beneficial as higher specific surface area of *ca*. 500 $m^2\ g^{-1}$ and larger pore volume are obtained. All catalyst materials studied herein contain micropores as well as mesopores in different sizes. The prepared Fe-N-C materials contain *ca*. 4 wt% of nitrogen and 1 wt% of iron, which is atomically dispersed as shown in Figure 1a. Electrocatalysts show high ORR activity in acidic media, low peroxide yield (<5%) and most importantly excellent stability (see Figure 1b). All in all, best-performing Fe-N-C material is promising alternative for the Pt/C catalyst in the PEMFC cathode.

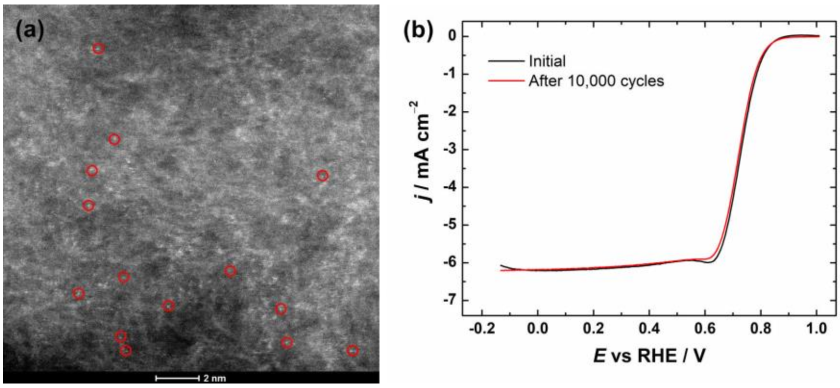

Figure 1: (a) STEM image and (b) ORR stability test results in O_2-saturated 0.5 M H_2SO_4 solution at 1900 rpm with Fe-N-C catalyst.

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