Hybrids of Reduced Graphene Oxide and Metal Oxides as Catalyst Support in Fuel Cells

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Abstract
Degradation of fuel cell components as cause for lifetime limitation is one main challenge in commercialisation of fuel cells.[1,2] Especially the corrosion of catalyst supports due to harsh conditions with highly variable potentials results in performance losses. In our recent work, we synthesise nanocomposites of reduced graphene oxide (rGO) and indium tin oxide (ITO) as potential cathode support for platinum nanoparticles in high temperature proton exchange membrane fuel cells (HT-PEMFCs). ITO has already demonstrated high durability in the presence of high cycled potentials.[3] Furthermore, the application of graphene-based carbon in low temperature PEMFCs has resulted in higher stabilities than conventional carbon black.[4] The hybrid structure serves for Pt nanoparticle stabilisation at the interface between ITO and rGO and can prevent rGO restacking and corrosion.[5]
Reduced graphene oxide was prepared by the use of Hummers method and a following thermal reduction. Then, the solvothermal ITO nanoparticle precipitation on rGO and finally the Pt deposition via the polyol method have been carried out. After every synthesis step the products were characterised by the use of scanning as well as transmission electron microscopy, EDS, XRD and other techniques. Particularly the precipitation of ITO nanoparticles was studied intensively by variation of synthesis parameters. In order to compare to reference catalyst materials, platinum has been deposited on carbon black as well as on multi-walled carbon nanotubes.
The X-ray diffraction pattern of the final platinum catalyst on ITO-rGO in Figure 1a shows the expected In_2O_3 reflexes (for ITO as Sn-doped In_2O_3) as well as rGO and Pt reflexes. The TEM images in Figure 1b and 1c prove the successful deposition of ITO on rGO by the atomic lattice distance of 0.29 nm, typical for the In_2O_3 (222) reflex. Furthermore, the determination of the platinum nanoparticle sizes by the use of TEM show diameters of about 2 nm on this alternative catalyst support. Thus, the system represents good conditions as electrocatalyst for the oxygen reduction reaction in fuel cells.

References
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Figures

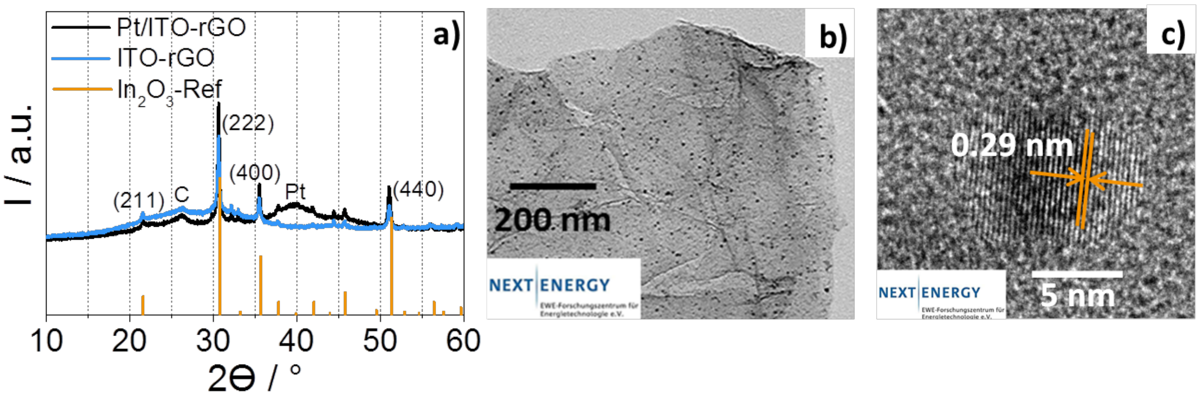

Figure 1 (a) X-ray diffraction of ITO-rGO and Pt on ITO-rGO, (b) TEM image of ITO-rGO and (c) HR-TEM image of ITO-rGO with ITO lattice planes.