ZIF-8 based composite catalysts for oxygen reduction electrocatalysis

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Polymer electrolyte fuel cells are next-generation energy conversion devices to meet the future green-energy demands. However, the strong bond energy of O_2 molecule makes it difficult to break electrochemically which as a result leads to the slower oxygen reduction reaction (ORR) kinetics at cathode.[1] In this work, we report on Fe/Co doped and CNT supported ZIF-8 based composite catalysts for boosting the ORR in 0.1 M KOH. The catalysts (ZIF-8@CNT) were prepared via high-temperature pyrolysis at 900 °C and characterized using various physicochemical techniques and employed as cathode materials in anion exchange membrane fuel cell (AEMFC).[2] All the synthesized catalysts, metal-free (ZNT-900), single-metal-doped (Fe-ZNT-900, Co-ZNT-900) and binary-metal-doped (Fe_1Co_1-ZNT-900, Fe_1Co_2-ZNT-900) carry a porous morphology with a good amount of N-moieties and the presence of FeCo alloys in the carbon skeleton of bimetallic materials. The rotating disc electrode (RDE) polarization curves showed that Fe_1Co_2-ZNT-900 exhibited the maximum half-wave potential ($E_{1/2}$) of 0.85 V *vs.* RHE which surpassed the commercial Pt/C catalyst ($E_{1/2}$ = 0.83 V) (Figure 1a). The Koutecky–Levich plots and RRDE measurement showed that the ORR followed mainly the 4e$^-$ reduction pathway with a peroxide (HO_2^-) yield of 22.5% for Fe_1Co_2-ZNT-900 catalyst (Figure 1b). The as-synthesized catalyst materials were further tested in H_2–O_2 AEMFC, where the Fe_1Co_2-ZNT-900 cathode delivered a maximum power density (P_{max}) of 0.171 W cm^{-2} and current density at 0.5 V ($j_{0.5}$) of 0.326 A cm^{-2}, which is very close to that of the Pt/C catalyst (P_{max} = 0.215 W cm^{-2} and $j_{0.5}$ = 0.359 A cm^{-2}). The prepared ZIF-8@CNT catalysts showed remarkable electrocatalytic ORR activity in 0.1 M KOH solution and fuel cell performance comparable to that of the benchmark Pt/C catalyst. All in all, the bimetallic ZIF-8@CNT catalysts performed quite well in AEMFC and the results were comparable to those of similar materials and these catalysts should be explored more in-depth to achieve more promising results in AEM fuel cells.

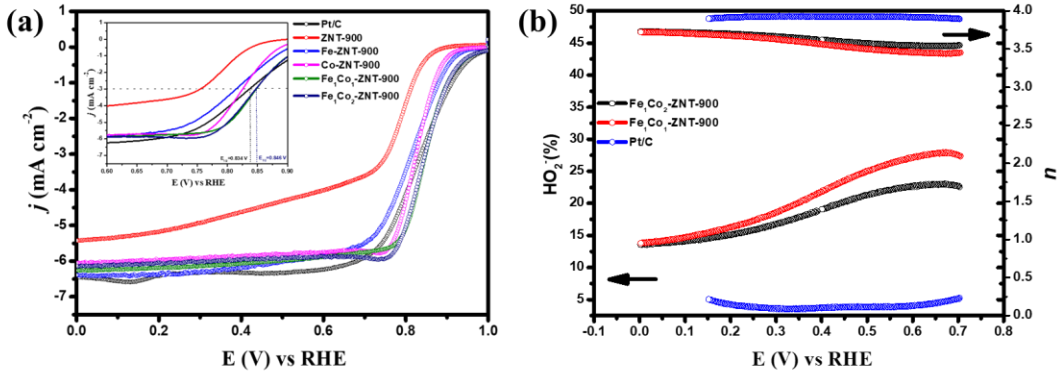

Figure 1: (a) RDE polarization curves for oxygen reduction in O_2-saturated 0.1 M KOH at 1900 rpm for all the catalyst materials and (b) HO_2^- yield and electron tranfer number (n) for the bimetallic catalyst materials.

Acknowledgements

The present work was financially supported by the Estonian Research Council (PRG723, PRG4, and PRG1509) and by the EU through the European Regional Development Fund (TK141, TK134, and TK143).

References

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