Dual-transition metal and nitrogen co-doped silicon oxycarbide-based catalysts for oxygen reduction at the high temperature PEM fuel cell cathode

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The worldwide transition to renewable energy will rely on the introduction and commercialisation of zero-emission and sustainable energy conversion devices. The high temperature proton-exchange membrane fuel cell (HT-PEMFC) is environmentally friendly energy conversion device suitable for heavy-duty transport, stationary, and aviation applications. One topical concern with HT-PEMFC is the development of efficient Pt-group-metal (PGM)-free oxygen reduction reaction (ORR) catalyst for the fuel cell cathode [1].
Most promising PGM-free catalysts for the HT-PEMFC cathode are the transition metal (TM) and nitrogen functionalised nanocarbon materials, e.g. Fe-N-C [1,2]. More recently, the dual-TM inclusion (e.g. Fe and Cu) has been investigated to achieve more promising ORR electrocatalysis performance compared to the single metal (e.g. Fe-N-C) catalysts [1]. Here we propose a novel silicon oxycarbide (SiOC)-based [3] dual-TM containing catalysts functionalised with N using the Zeolitic Imidazolate Framework-8. The prepared catalysts show promising results during the rotating ring-disk electrode (RRDE) half-cell ORR testing in 0.5 M H_3PO_4 (Figure 1a) compared to the commercial (com.) Pt/C and com. Fe-N-C (Pajarito Powder, LLC). More importantly, to assess the catalyst ORR performance in the conditions more similar to HT-PEMFC, the gas diffusion electrode (GDE) half-cell tests [4] were performed and the catalyst activity of CuFe-SiOC similar to com. Fe-N-C was observed if the *j-E* curves without the iR-drop correction are compared (Figure 1b).

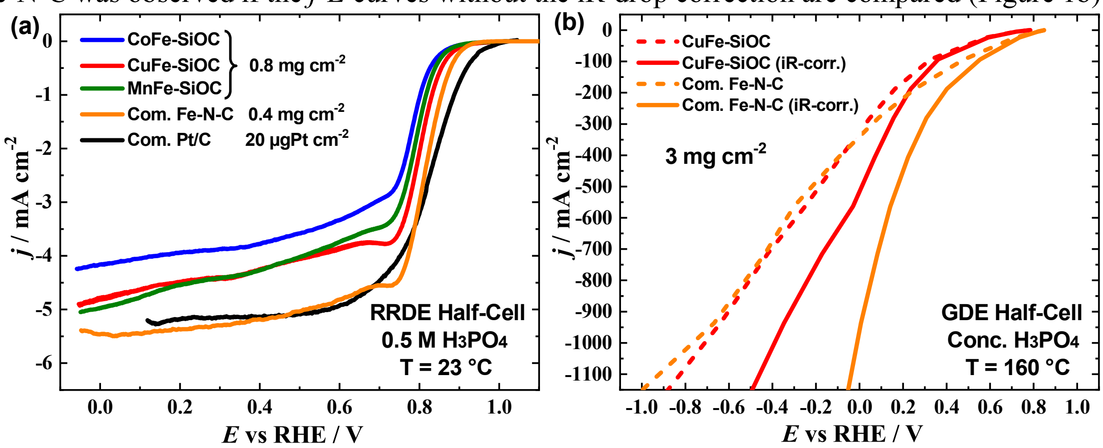

Figure 1: Oxygen reduction reaction studies with (a) RRDE (rotation rate 1600 rpm), (b) GDE half-cell setup with dual-transition metal and nitrogen co-doped silicon oxycarbide-based catalysts and commercial Fe-N-C, Pt/C materials as cathode catalysts.

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