Oxygen-Tolerant H₂O₂ Reduction Catalysis by Iron Phosphate Coated Iron Oxides

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Abstract : We report on the decisive role of iron phosphate (FePO₄), formed in-situ during the electrochemical characterization, played in the electrocatalytic activity, especially its oxygen tolerance of iron oxides towards H_2O_2 reduction. Iron oxides studied including, Nanorod arrays (NRs) of β-FeOOH, γ-Fe₂O₃, α-Fe₂O₃, α-Fe₂O₃ nanosheets (α-Fe₂O₃NS), α-Fe₂O₃ nanoparticles (α -Fe₂O₃NP), were synthesized using chemical bath deposition. The nanostructure was controlled simply by adjusting the composition of precursor solution and reaction duration for CBD process, whereas the crystal phase was controlled by adjusting the annealing temperature. It was found that iron phosphate (FePO₄) was deposited in-situ onto the surface of this nanostructured α -Fe₂O₃ during the electrochemical pretreatment in the phosphate electrolyte, and both FePO₄ and α -Fe₂O₃ showed the activity in catalysing the electrochemical reduction of H₂O₂. In addition, the interaction/compatibility between deposited FePO4 and iron oxides has a decisive effect on the overall electrocatalytic activity of the resultant electrodes; FePO₄ only showed synergetic effect on the overall electrocatalytic activity of α-Fe₂O₃NR and α-Fe₂O₃NS. Both α-Fe₂O₃NR and α -Fe₂O₃NS showed two reduction peaks in phosphate electrolyte containing H₂O₂, one being pH-dependent and related to the electrocatalytic properties of FePO₄, and the other one being pH-independent and only related to the intrinsic electrocatalytic properties of α-Fe₂O₃NR and α-Fe₂O₃NS. However, all iron oxides showed only one pH-independent reductive peak in non-phosphate electrolyte containing H₂O₂. The synergesitic catalysis exerted by FePO₄ with α-Fe₂O₃NR or α-Fe₂O₃NS providing additional oxygen-insensitive active site for H_2O_2 reduction, which allows their applications to electrochemical detection of H_2O_2 without the interference of O_2 involving in oxidase-catalyzed chemical processes.

Keywords : H₂O₂ reduction, Iron oxide, iron phosphate, O₂ tolerance

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