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Oxygen-Tolerant H_2O_2 Reduction Catalysis by Iron Phosphate Coated Iron Oxides

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Abstract : We report on the decisive role of iron phosphate ($FePO_4$), 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-Fe_2O_3, α-Fe_2O_3, α-Fe_2O_3 nanosheets (α-Fe_2O_3NS), α-Fe_2O_3 nanoparticles (α-Fe_2O_3NP), 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 ($FePO_4$) was deposited in-situ onto the surface of this nanostructured α-Fe_2O_3 during the electrochemical pretreatment in the phosphate electrolyte, and both $FePO_4$ and α-Fe_2O_3 showed the activity in catalysing the electrochemical reduction of H_2O_2. In addition, the interaction/compatibility between deposited $FePO_4$ and iron oxides has a decisive effect on the overall electrocatalytic activity of the resultant electrodes; $FePO_4$ only showed synergetic effect on the overall electrocatalytic activity of α-Fe_2O_3NR and α-Fe2O_3NS. Both α-Fe_2O_3NR and α-Fe_2O_3NS showed two reduction peaks in phosphate electrolyte containing H_2O_2, one being pH-dependent and related to the electrocatalytic properties of $FePO_4$, and the other one being pH-independent and only related to the intrinsic electrocatalytic properties of α-Fe_2O_3NR and α-Fe_2O_3NS. However, all iron oxides showed only one pH-independent reductive peak in non-phosphate electrolyte containing H_2O_2. The synergesitic catalysis exerted by $FePO_4$ with α-Fe_2O_3NR or α-Fe_2O_3NS 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 : H_2O_2 reduction, Iron oxide, iron phosphate, O_2 tolerance
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