Effect of tetravalent dopants on hematite nanostructure for enhanced photoelectrochemical water splitting

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Improvement of the electrical conductivity of semiconductor metal oxides is one of the most profound challenges in the development of high performance photoanodes for photoelectrochemical (PEC) water splitting. Hematite (α-Fe_2O_3) is considered an ideal metal-oxide semiconductor photoanode for PEC applications, owing to its stability, suitable band gap (2.2 eV), low cost and non-toxic nature. However, pristine α-Fe_2O_3 exhibits poor performance due to short hole diffusion lengths (2–4 nm) and low electron mobility. Doping of α-Fe_2O_3 photoanodes has been extensively investigated to improve its photoelectrochemical properties. In this work, the influence of tetravalent dopants such as Si^{4+}, Sn^{4+}, Ti^{4+}, and Zr^{4+} on the hematite (α-Fe_2O_3) nanostructure for enhanced photoelectrochemical (PEC) water splitting are reported. The tetravalent doping was performed on hydrothermally grown akaganeite (β-FeOOH) nanorods on FTO (fluorine-doped tin-oxide) substrates via a simple dipping method for which the respective metal-precursor solution was used, followed by a high-temperature (800◦ C) sintering in a box furnace.