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Improvements of the performances of iron-based solar water splitting photocatalysts by Sn and Nb dopants

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For some time, my research group has been focusing on the study of low-cost iron-based semiconductors to act as photocatalysts in solar water splitting to produce sustainable fuel. Among several materials, hematite (Fe_2O_3) and pseudobrookite iron titanate (Fe_2TiO_5) have proven to be very promising, as they are inexpensive, non-toxic, and possess relatively small band gap values.[1,2] In the case of Fe_2TiO_5 nanostructure, the doping with tin and niobium, separately, could be carried out through a simple solvothermal method. Advanced characterization indicated that single-phase Sn- and Nb-doped Fe_2TiO_5 nanoparticles with dimensions close to 30 nm, presenting optical band gap values of 2.1 eV, were obtained. Bare, Sn-, and Nb-doped Fe_2TiO_5 were irradiated with simulated sunlight, evolving 59.2, 297.6, and 344.0 μmol h^{-1} g^{-1} of O_2, respectively (Fig. 1). Such unprecedented outcomes reflect the large improvement that doping Fe_2TiO_5 with Sn and Nb atoms confers to the photocatalytic water splitting activity. Photoelectrochemical tests indicated photocurrent density increments from 2.4 μA cm^{-2} at 1.23 V_{RHE}, for pristine Fe_2TiO_5, to 36.7 and 70.7 μA cm^{-2} at 1.23 V_{RHE} for Sn- and Nb-doped Fe_2TiO_5, respectively, accompanied by overpotential drops of 0.04 and 0.1V. In the case of hematite, the O_2 production enhanced by three times after Nb doping. Overall, the doping procedures led to extension of the minority carrier diffusion lengths and to reduction in the charge carrier transfer resistances at the solid/liquid interfaces, as indicated by electrochemical impedance spectroscopy.

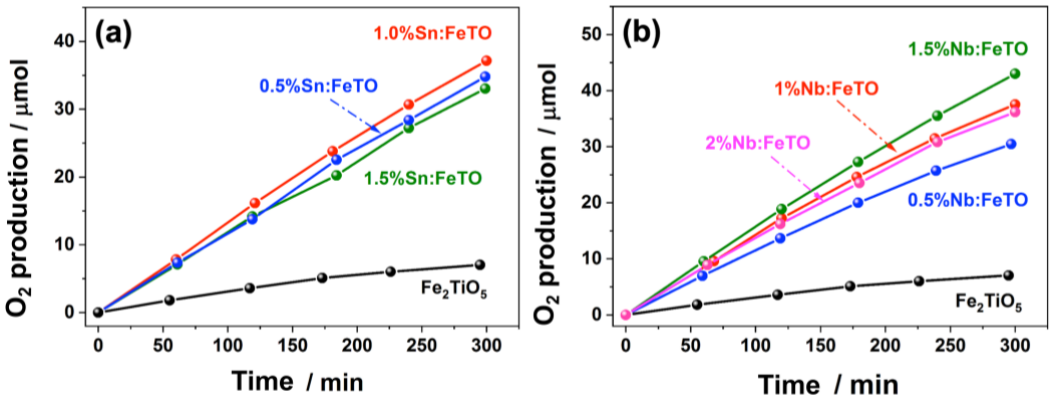

Figure 1. Oxygen production with the Sn- (a) and Nb-doped (b) Fe_2TiO_5 nanoparticles.

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References

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