Discovering a selective semimetal element to increase hematite photoanode charge separation efficiency

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Figure S1. X-ray diffraction patterns of the hematite thin films deposited with different concentrations of the colloidal solution (50 to 500 mg.ml-1): a) unmodified Hematite film; b) Sb-modified hematite film.
Figure S2. X-ray diffraction pattern of the hematite (Fe$_2$O$_3$) thin films deposited over FTO substrate along with the pattern of the as-synthesized magnetite (Fe$_3$O$_4$) nanoparticles. The inset photographs show the FTO films before and after phase transformation from magnetite to hematite at 850°C.
**Figure S3.** HAADF-STEM image of the cross-section analysis of the Sb-hematite film sintered at 850°C. The inset shows the EDS maps of the same region.
Figure S4. Magnetite nanoparticle characterization: (a) Low magnification TEM image of the magnetite nanoparticles used in this work along with HRTEM images showing the (111) lattice fringes with $d_{\text{hkl}}$ equal 4.8 Å, the scale bars have 5 nm; b) Particle size distributions obtained from the TEM analysis.
Figure S5 - Variation of the pure and Sb-hematite film thickness as a function of the magnetite nanoparticle concentration in the colloidal solution. The insets show SEM images of Sb-hematite films.
**Figure S6** - Current density, $J$, against Voltage, $V_{\text{RHE}}$, curves for (a and b) unmodified, and (c and d) Sb-hematite films with different thickness measured under dark and simulated sunlight irradiation at front side and back side, respectively.
Figure S7. UV-Vis spectra of hematite films deposited with different nanoparticle concentration in colloidal solution (from 50 to 500 mg ml\(^{-1}\)): a) hematite and b) Sb- hematite film.
**Figure S8.** \( J_{PH} \) x V curves in darkness and under illumination for the unmodified hematite and Sb-hematite film in 1M NaOH electrolyte with and without 0.5M H\(_2\)O\(_2\).
Figure S9. Electrochemical impedance spectra (EIS) obtained for unmodified (blue) and Sb-Hematite (green) films electrode in a 1.0 mol L⁻¹ NaOH solution.