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Manipulating oxygen vacancy in srtio3 to achieve enhanced photoelectrochemical performance

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Exploiting sustainable and environmentally friendly energy is becoming a worldwide challenge. Among all renewable energy sources, solar energy stands out for being harmless, inexhaustible, and easily developed, therefore it has been universally recognized and explored. Photoelectrochemical water splitting technology is a promising strategy to achieve the conversion from solar energy to hydrogen, which has drawn considerable research interest. According to previous reports, the solar-to-hydrogen conversion efficiency is highly subject to the separation and orientational transport of charge carriers, which can be effectively boosted by modifying the composition and structure of catalyst material. Herein, we present a straightforward and facile strategy to improve the photoelectrochemical activity of SrTiO3 by adjusting the oxygen vacancy and the Ti3+ concentration in SrTiO3 through a non-stoichiometric method. STO samples were first prepared by the sol-gel method, through which nanoparticles with uniform morphology and size were obtained. Furthermore, reducing the molar ratio of strontium to titanium in the reactant achieved dual control of increasing oxygen vacancies and suppressing Ti3+ defects. Compared to the original SrTiO3, the ultraviolet absorption at the SrxTiO3 (x<1) sample is significantly strengthened, probably because the oxygen vacancies in proper concentration provide a visible light absorption site. The valence and conduction bands of the samples were measured using XPS and electrochemical methods, respectively. The results demonstrated that the difference in oxygen vacancies and Ti3+ concentrations lead to a slight change in the electrical structure of SrTiO3. The SrxTiO3 (x<1) sample has a more positive conduction band, which facilitates the generation of photogenerated carriers. The carrier recombination is also significantly decreased, as confirmed by the photoluminescence spectrum. In the range of 1.2-1.4V versus RHE, the photocurrent density produced by SrxTiO3 (x<1) is higher than that of the original sample and has a tendency to quickly saturate, further suggesting that the presence of oxygen vacancies is advantageous to PEC performance when using SrTiO3 as photoanode. This work introduced a simple method for regulating oxygen vacancies and Ti3+ defects in SrTiO3, in attempt to enhancing its photoelectrochemical activity for water splitting H2 evolution, which may offer new inspiration to the defect engineering of perovskite.

Biography

Xiaoli Ran is currently a PhD candidate at Northeast University and she is engaged in research related to the theory and application of photoelectric chemical (PEC) water decomposition technology for green hydrogen evolution.

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