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Visible light Photocurrent enhancement in STO thin films through Nb doping and Au Plasmons

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1. Introduction

Photoelectrochemical (PEC) reaction pioneered by Fujishima and Honda wherein a semiconductor photocatalyst is used for converting solar energy into chemical energy has been widely regarded as the means to sustainable energy.[1-3] Over the years it has been established that an efficient semiconductor photocatalyst requires suitable band gap for harvesting the entire solar energy and proper band edge potential for redox reaction to be feasible.[4] Among the various semiconductor photocatalysts, $SrTiO_3$(STO) has gained a lot of attention since its band edge positions are feasible for redox reactions.[5,6] But its visible light activity is limited since its band edge positions lies in the UV region. To enhance the visible light absorption of STO there has been a lot of widely investigated techniques such as doping an additional element,[7] utilization of hot electrons[8] which are directly injected into the conduction band (CB) of the semiconductor over the Schottky barrier with the assistance of the surface plasmon resonance (SPR) and there exist a few theoretical studies which suggest the structural defect of the STO particularly Ti vacancies and Sr vacancies can also lead to the visible activity in STO.[9]

2. Results and discussions

We studied the effect of Nb doping into the STO for promoting the electron transport by Nb electron donors. Increase in the visible light activity was observed which is possibly associated with the creation of Sr defects that effectively acts as p-type co-dopants as the counterpart for Nb electron donors. Here we have synthesized Nb-doped STO films by wet chemical route and have studied the transmission and photocurrent characteristics (Figure 1) of the pristine STO, Nb-doped STO and Au-loaded Nb-STO. An anodic photocurrent was observed with all STO samples. The increase in the conductivity by the both carriers as well as the defect-induced visible excitation was clarified to increase the photocurrent.[9] We also examined the interplay between the defect-mediated excitations and plasmon on the visible photocurrent enhancement.

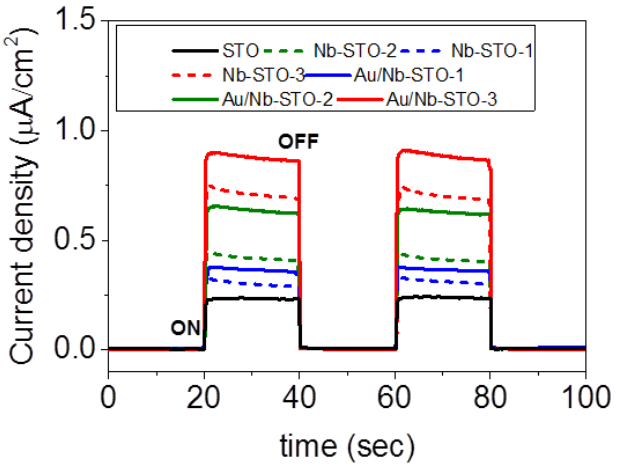

Figure 1. Comparison of photocurrent spectra various STO films.

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