Ag-nanoislands Mediated TiO_2 Multilayer Thin Films towards Perfect Absorber

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1. Introduction

Under illumination, metallic nano-particles show a characteristic absorption peak originated due to localized surface plasmon resonance (LSPR) [1]. It exhibits strong absorption at specific wavelength region depending upon particle size, shape, fill fraction and optical constants of the ambient materials and then transformed the absorbed energy into ohmic heat or other forms of energy. Proper tuning of the parameters to grow metal nanoislands can cover a broad absorption zone and hence, has the potential to become perfect absorber. It has a great importance in solar energy harvesting and thermal tailoring. Beside this, it can enhance the performance of light emitting diodes, sensors and photodetectors [2].

In this work, an optimized Ag nanoislands of different distribution and TiO_2 thin film has been grown sequentially several times at room temperature to achieve high absorbing film.

2. Experimental

Ag nanoisland and amorphous TiO_2 thin films has been deposited alternatively on ultrasonically cleaned glass substrate with area 1×1 cm^2 by sequential laser ablation of Ag and TiO_2 target using Pulsed Laser Deposition (PLD) technique. The details of the operating laser parameters are reported somewhere else [3,4]. Ag nanoislands thin film was deposited inside a vacuum chamber having base pressure 1×10^{-6} Torr where as the TiO_2 thin film was grown under oxygen environment having working pressure 20 mTorr. A thick Ag layer was deposited on glass substrate to set transmittance to almost zero. Laser energy was kept 50 mJ/pulse and 100mJ/pulse during growth of Ag nanoislands and TiO_2, respectively. The reflectance of the films was measured using Spectroscopic Ellipsometer (J. A. Woollam Co., Model: M-2000).

3. Results and discussion

Initially, the Ag nanoislands thin film was optimized in such a way that it could absorb broader wavelength region. After repetition of several sequential depositions of Ag nanoislands and the TiO_2 layers, the best broadband absorption performance of the multilayer structure is achieved. **Figure 1** shows the best result of the optimized multilayer structure. The absorption over the whole investigated wavelength (400-900 nm) holds higher than 80% and shows highest absorbance (92%) near 700 nm region.

4. Conclusions

In conclusion, an interplay of alternating optimized Ag nanoislands and TiO_2 thin layers has been carried out to achieve maximum absorption. After repetition of several layers of Ag nano-islands and the TiO_2 thin film alternatively, the absorbance of the multi layer structure is achieved ~92% near 700 nm wavelength region and higher than 80% throughout the specified range.

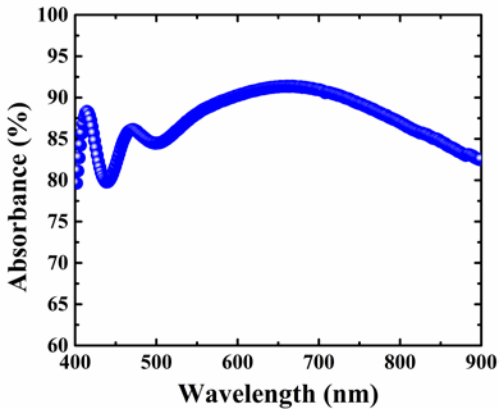

Figure 1. Absorbance spectra of the best sample.

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