$Ag@Nb_2O_5$ Plasmonic Blocking Layer for Higher Efficiency Dye-sensitized Solar Cells

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Supporting Information

Table S1. Structural and optical properties of Silver incorporated Nb_2O_5 films, deposited on quartz substrate prepared by RF magnetron sputtering technique and are annealed at a temperature of 600 ˚C in air.

Sample code	Band gap	Average Transmittance	Surface roughness (nm)	Position of the peak		Average Crystalline size (nm)	FWHM (deg)	strain
				001	200			
NAg0	4.24	86.1	1	22.647	28.805	16	0.6436	0.00392
NAg1	4.23	82.4	2.6	22.635	28.73	16	0.5014	0.00465
NAg3	4.21	78.5	-	22.634	28.732	11	0.7230	0.00720
NAg5	4.22	68.4	6.5	22.609	28.764	12	0.6500	0.00746
NAg10	4.20	67.8	6.3	-	28.77	11	0.7325	0.00655

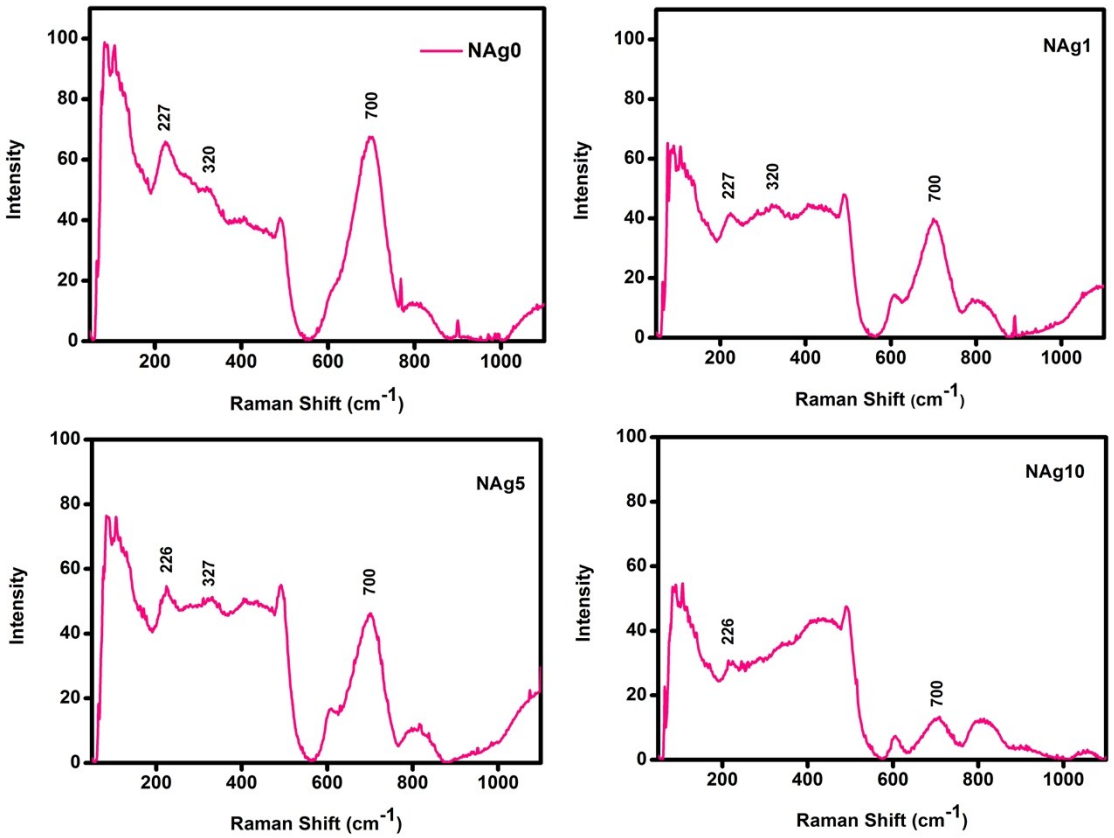

Figure S1 Micro Raman spectra of pure (NAg0) and silver incorporated with 1, 5 & 10 wt.% of Ag in Nb_2O_5 films by RF magnetron sputter process on a quartz substrate and post deposition annealed at a temperature of 600˚C.

Table S2 Binding energy values obtained from XPS analysis of pure and Ag incorporated (5 and 10 wt% respectively) Nb_2O_5 thins prepared on quartz substrate by RF magnetron sputter technique. The films were air annealed at a temperature of 600 ˚C after deposition in a controlled furnace at atmospheric pressure.

Sample code	Binding energy (eV)					
	Nb $3d_{5/2}$	Deconvoluted Nb $3d_{5/2}$	Nb $3d_{3/2}$	Deconvoluted Nb $3d_{3/2}$	Ag	
					$3d_{5/2}$	$3d_{3/2}$
NAg0	206.85	206.35	209.65	209.15	-	-
		206.85		209.65		
		207.25		210.05		
NAg5	206.95	206.45	209.75	209.25	367.75	373.75
		206.95		209.75		
		207.35		210.15		
NAg10	207.05	206.55	209.85	209.35	367.75	373.75
		207.05		209.85		
		207.55		210.35		

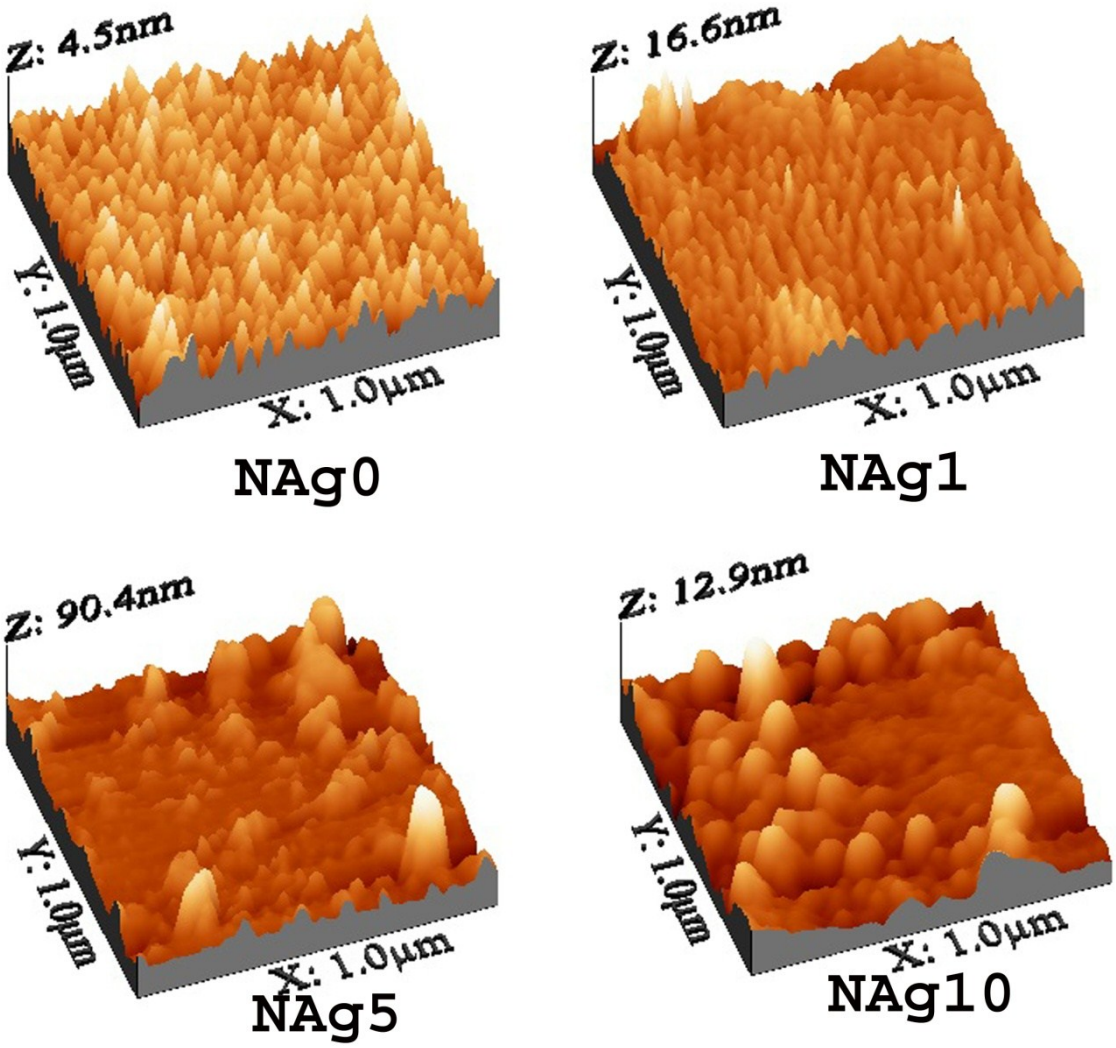

Figure S2 AFM images of pure (NAg0) and 1 wt.%, 5 wt% and 10 wt.% of Ag incorporated Nb_2O_5 films (NAg1, NAg5 and NAg10) by RF magnetron sputter process on a quartz substrate and post deposition annealed at a temperature of 600˚C.

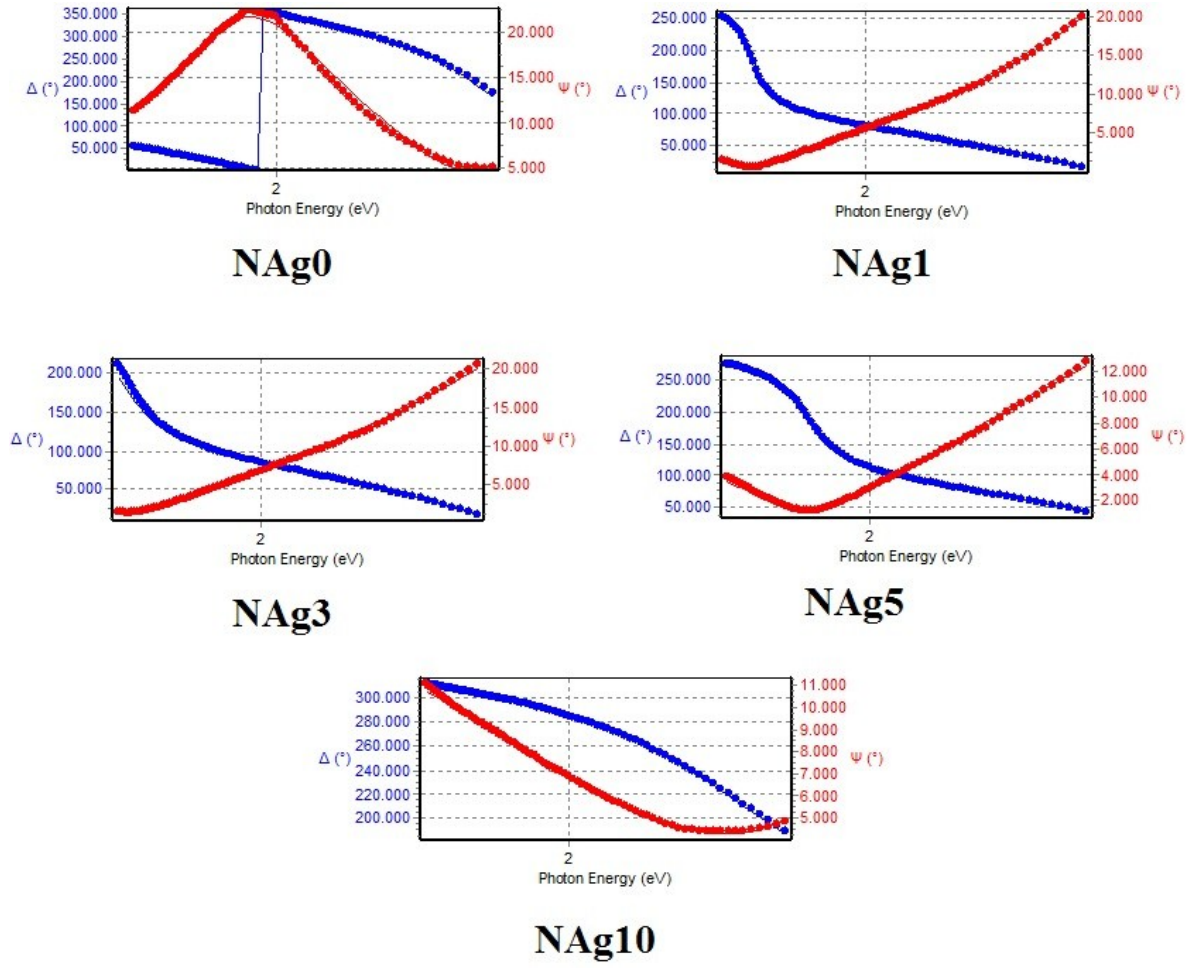

Figure S3 Experimental and fitted data of Delta (Δ) and Psi (ψ) values taken from spectroscopic ellipsometric measurements of pure and Ag incorporated Nb_2O_5 films deposited on a quartz substrate by RF magnetron sputter process. The films were air annealed at a temperature of 600 ˚C in a controlled furnace at atmospheric pressure. The experimental data is fitted by a three-layer model. Dispersion equation for fitting Nb_2O_5 layer is Single Lorenz oscillator because of its insulating nature.

Table S3 Fitted ellipsometric data of pure and Ag incorporated Nb_2O_5 films deposited on a quartz substrate by RF magnetron sputtering technique. The films are air annealed at a temperature of 600 ˚C after deposition in a controlled furnace at atmospheric pressure.

Sample code	$(\chi)^2$	Thickness (nm)	Refractive index (550 nm)	Dielectric constant (550 nm)
NAg0	1.48	156 ±0.4	2.28	5.21
NAg1	0.045	93 ±0.3	2.29	5.26
NAg3	0.40	110 ±1	2.40	5.74
NAg5	0.334	106 ±2	2.35	5.51
NAg10	0.167	62 ± 6	2.50	6.27

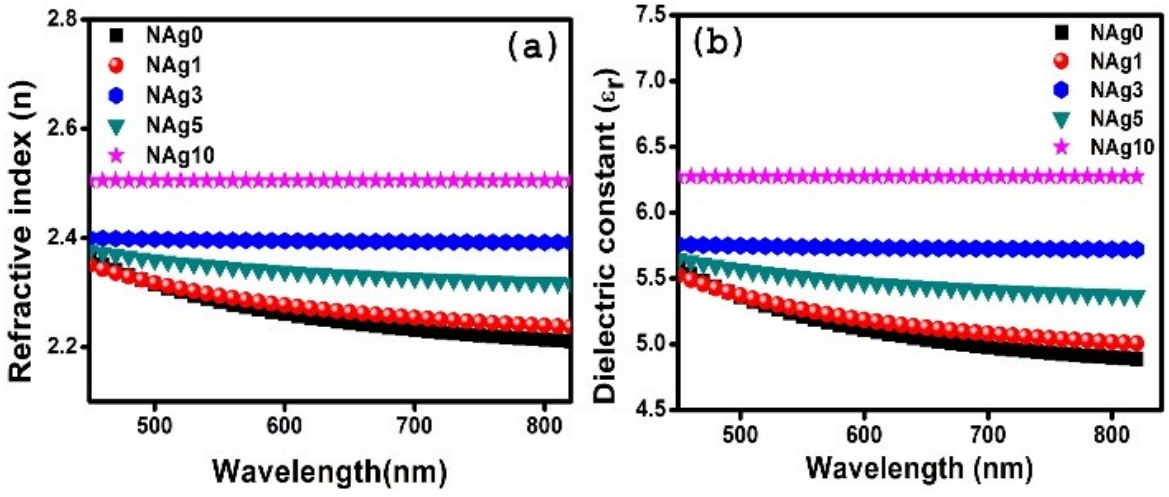

Figure S4 (a) Variation in refractive index and (b) dielectric constant of pure and Ag incorporated Nb_2O_5 films deposited on a quartz substrate prepared by Rf magnetron sputtering process and post deposition annealed at a temperature of 600˚C.

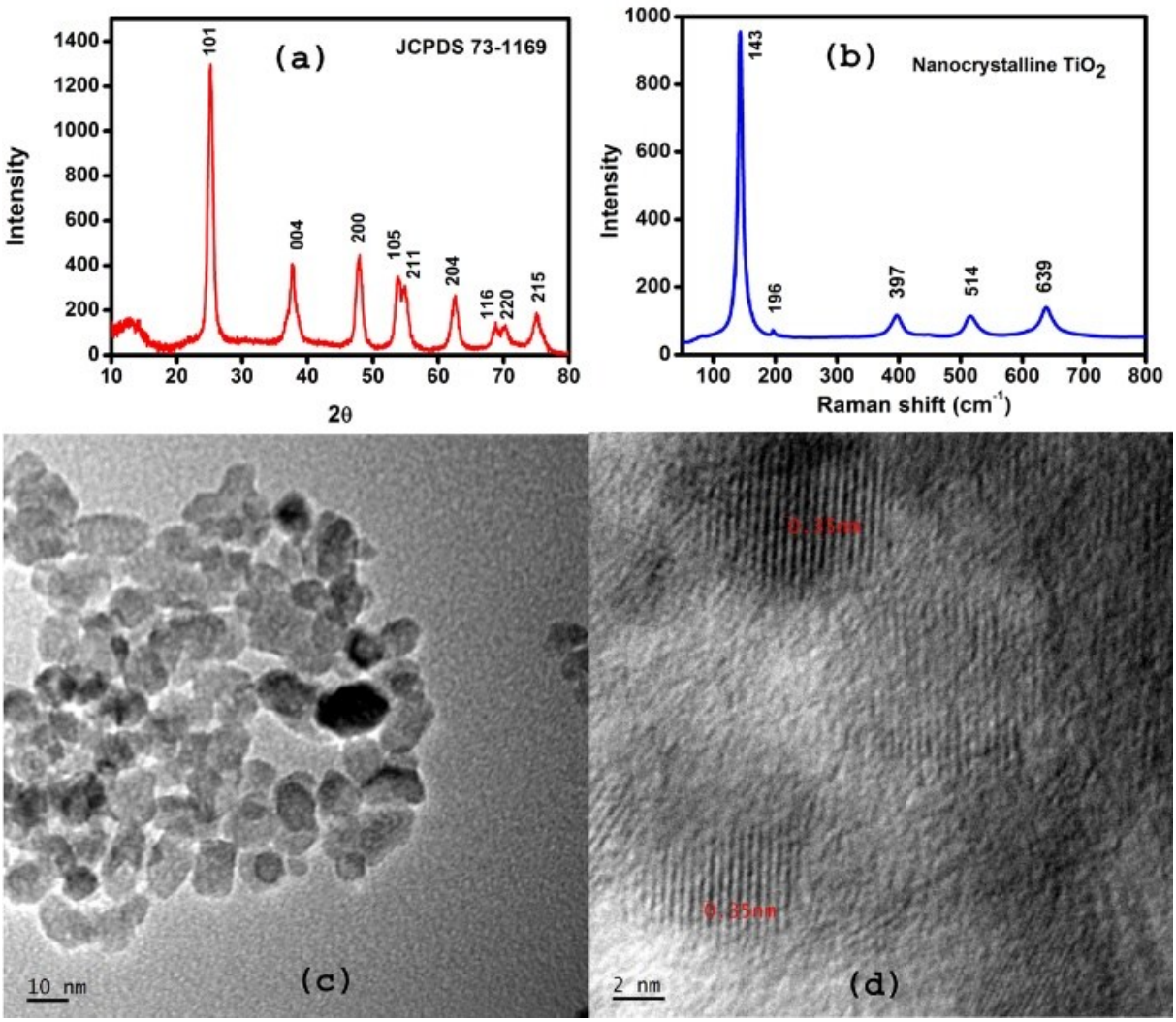

Figure S5 (a) XRD pattern of TiO_2 nanoparticles (b) micro-Raman spectra of TiO_2 nanoparticles (c) TEM image of the TiO_2 particles and (d) its high resolution image depicting 0.35 nm lattice spacing for (101) lattice reflection plane of anatase phase (JCPDS card 73-1169).

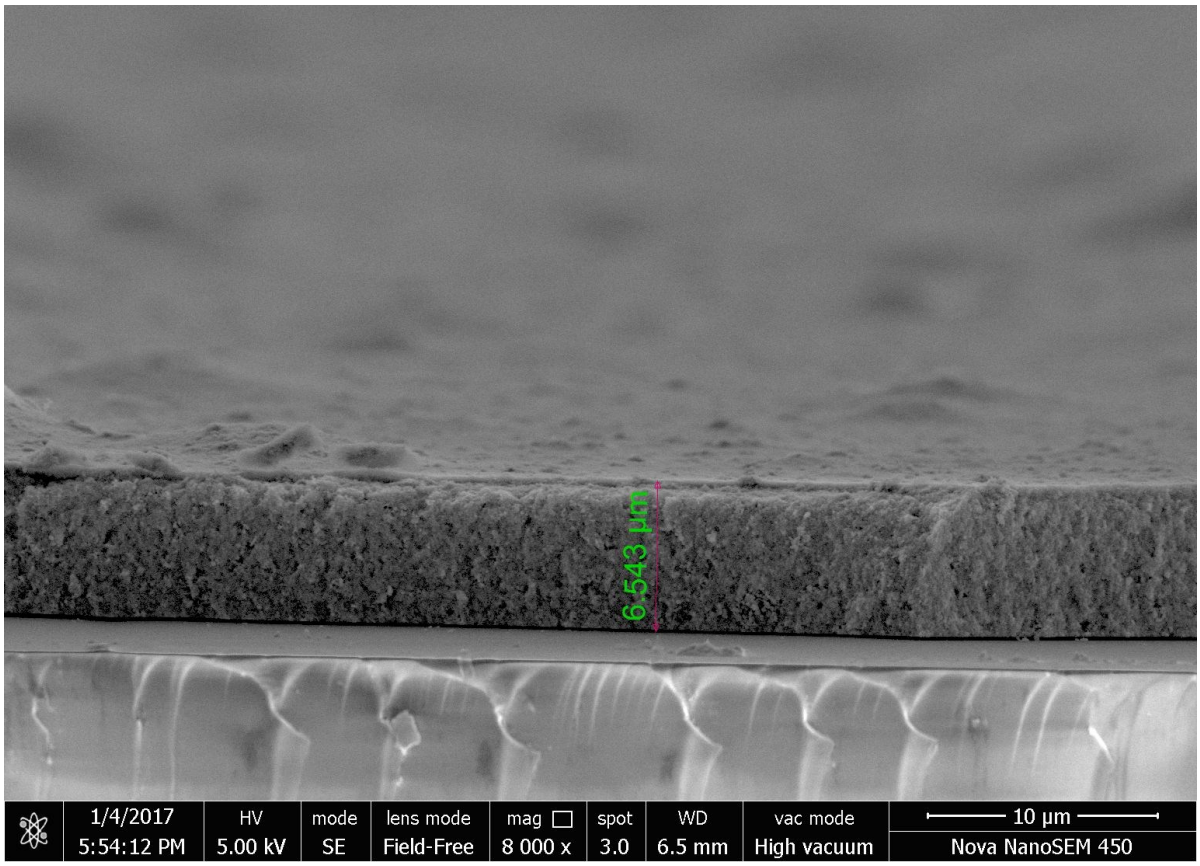

Figure S6 Cross Sectional image of TiO_2 photoanode prepared by spray pyrolysis technique depicting a thickness of ~6.5 µm.

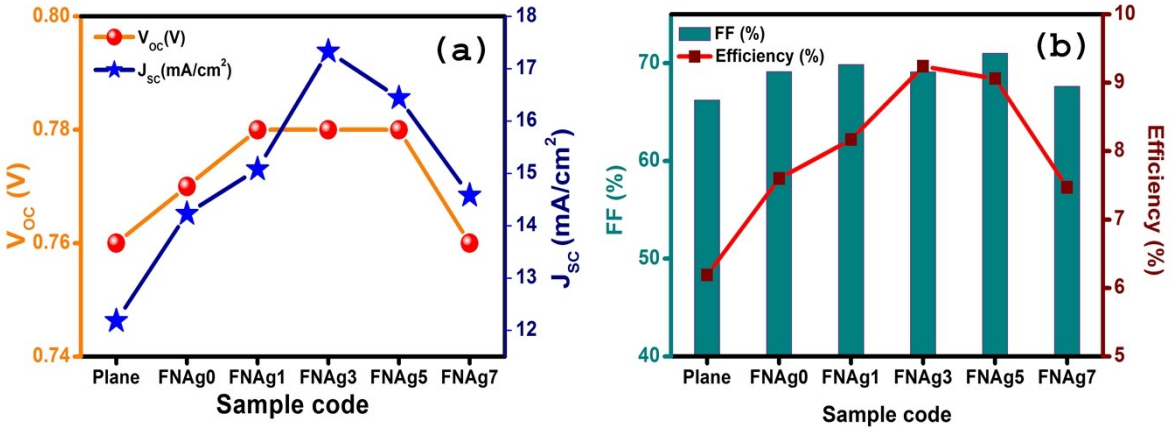

Figure S7 (a) Variation of open-circuit voltage and current density (b) Fill factor and efficiency with respect to silver incorporation in Nb_2O_5 blocking layer.

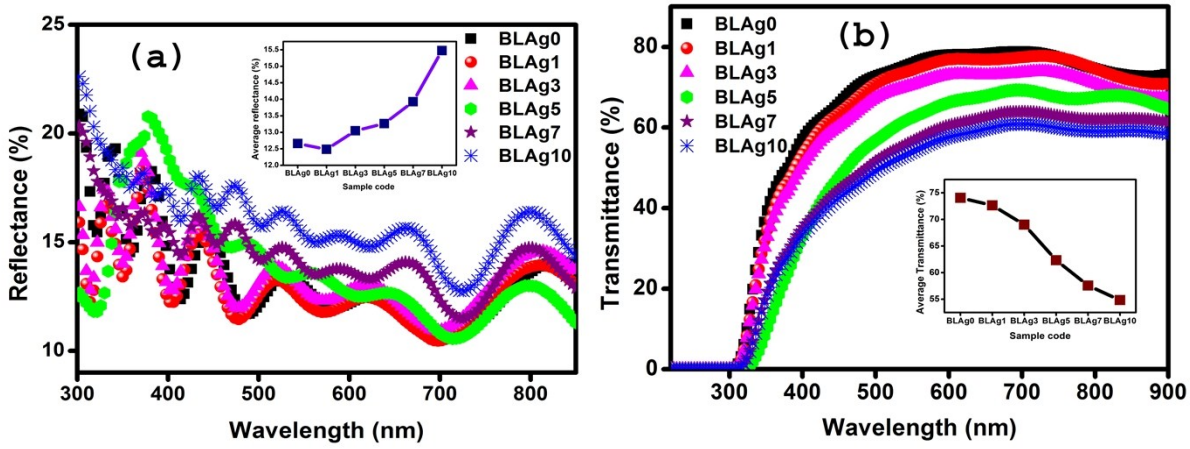

Figure S8 (a) Reflectance spectra and (b) Transmittance spectra, of plasmonic blocking layers on FTO glass plate (Ag wt %% 1, 3, 5, 7, 10) and non plasmonic Nb_2O_5