

Hole Transport Material Free-NiO/g-C₃N₄ incorporated Methylammonium Lead Iodide based Perovskite Solar Cells

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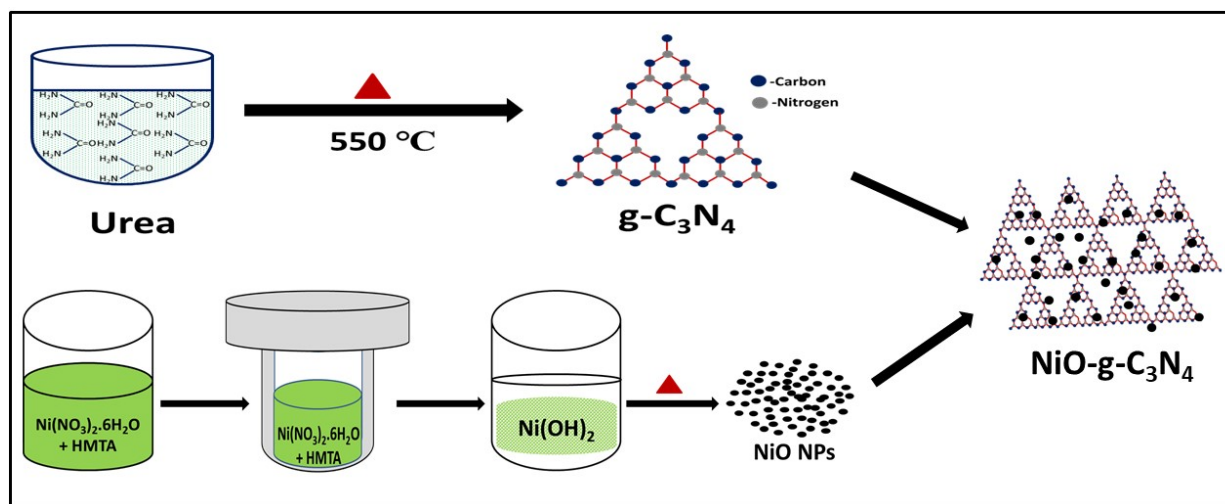


Fig.S1: Preparation of NiO-g-C₃N₄ nanocomposites

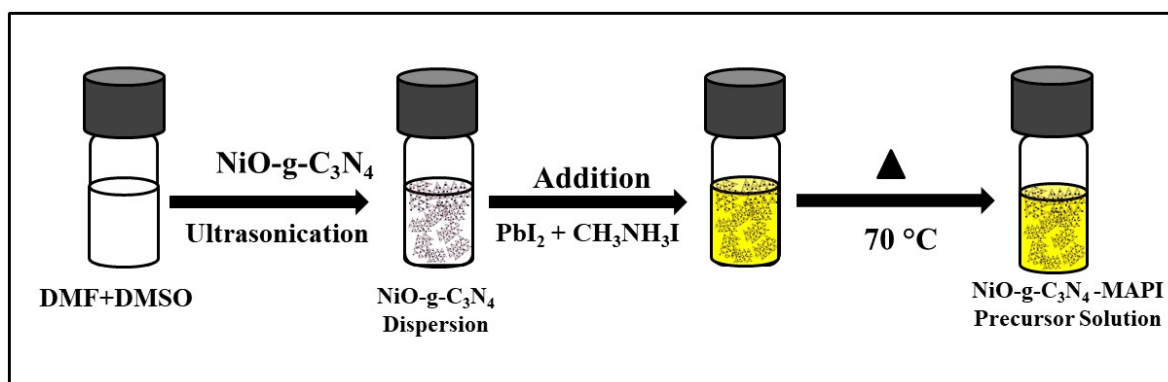


Fig.S2: Preparation of NiO-g-C₃N₄ incorporated MAPI precursor solution.

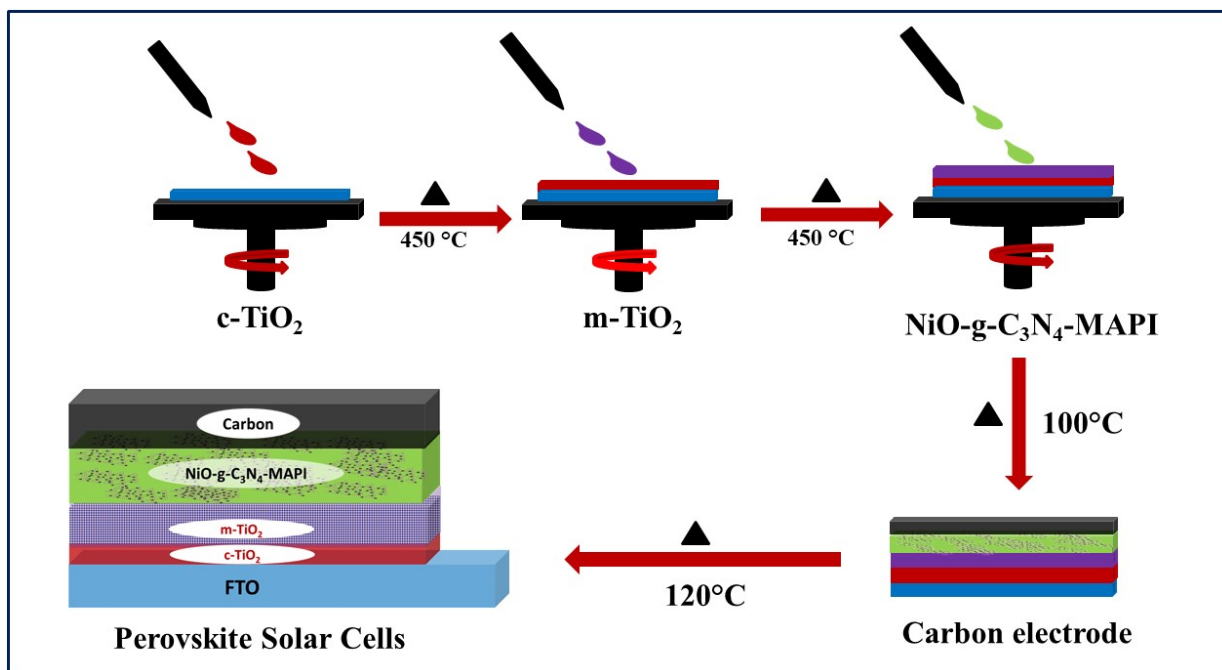


Fig.S3: Fabrication process of NiO-g-C₃N₄ incorporated MAPI based PSCs

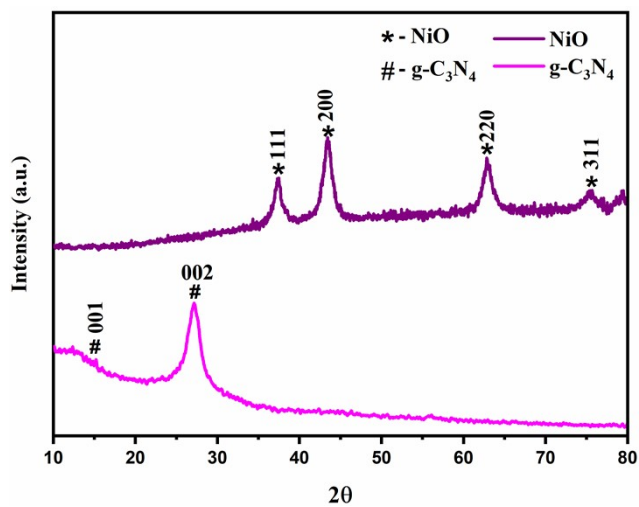


Fig.S4. a) XRD pattern of NiO and g-C₃N₄

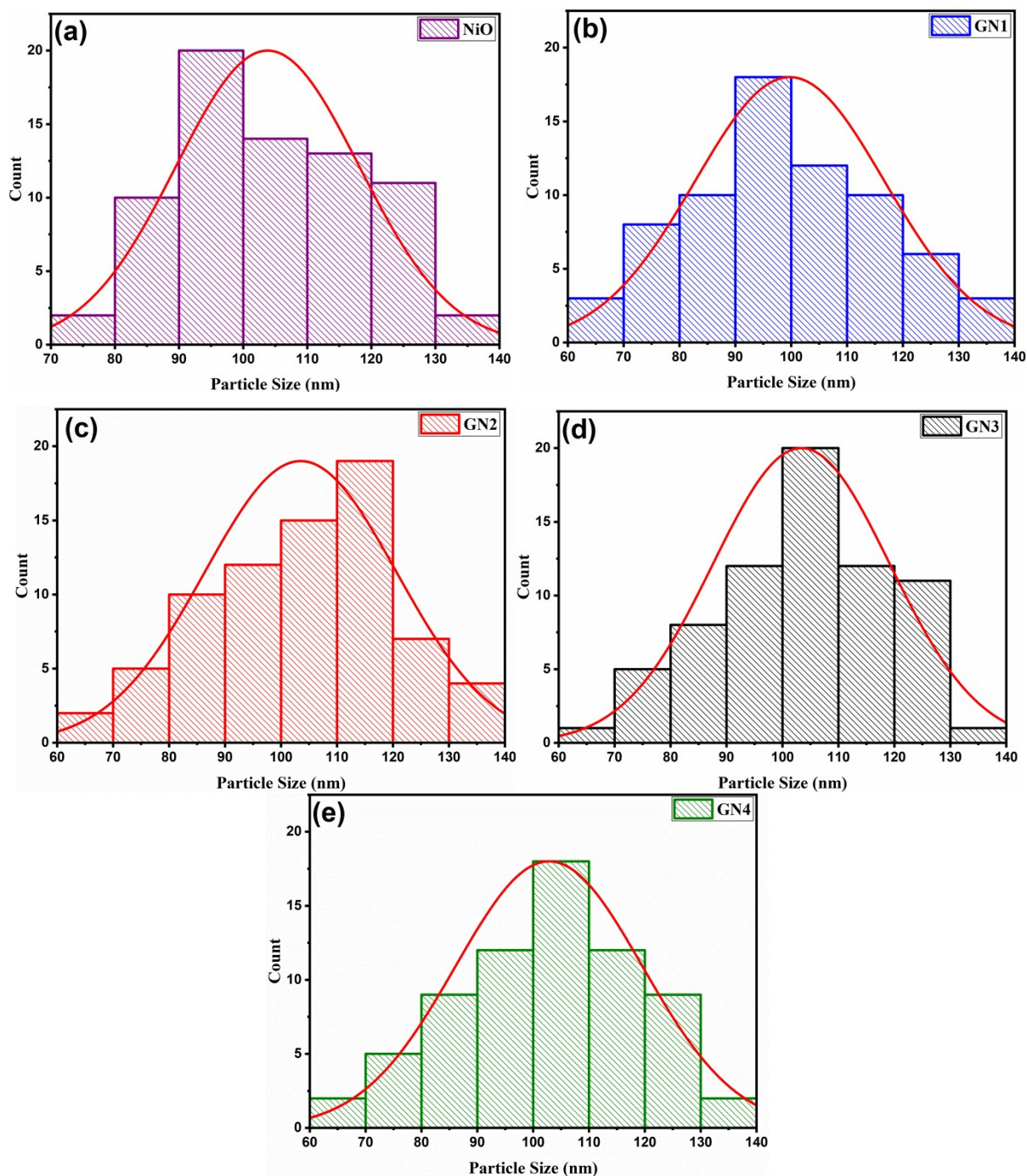


Fig.S5. Particle size distribution of NiO-g-C₃N₄ nanocomposite using FE-SEM image a) NiO, b) GN1, c) GN2 d) GN3 and e) GN4

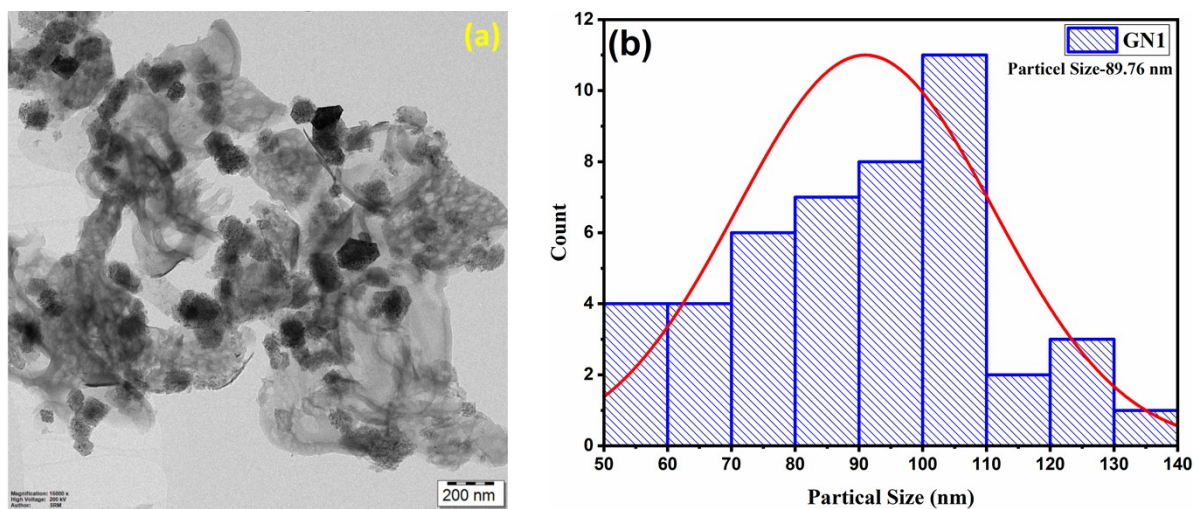


Fig.S6. Particle size distribution of NiO-g-C₃N₄ nanocomposite (GN1 sample) using HR-TEM image

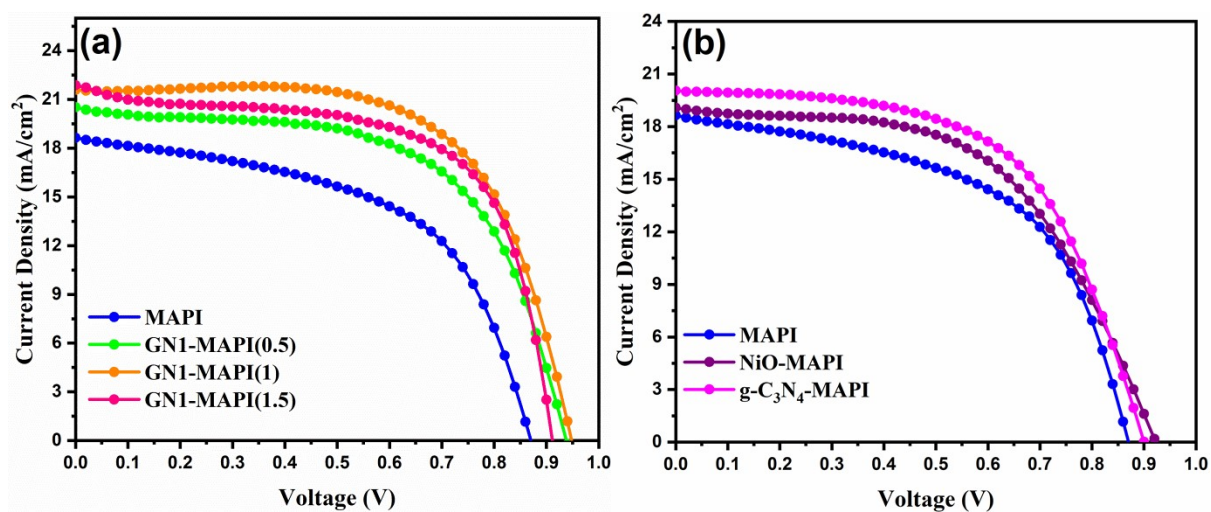


Fig.S7. J-V curve of a) MAPI, GN1-MAPI(0.5), GN1-MAPI(1) and GN1-MAPI(1.5) based PSCs and b) MAPI, NiO-MAPI and g-C₃N₄-MAPI based PSCs

Table: S1. Photovoltaic parameters of MAPI, GN1-MAPI(0.5), GN1-MAPI(1) and GN1-MAPI(1.5) based PSCs

Perovskite Solar cells	Amount of NiO- g-C ₃ N ₄ (mg/mL)	V _{oc} (V)	J _{sc} (mA/cm ²)	FF	PCE (%)
MAPI	-	0.87	18.60	0.53	8.58
GN1-MAPI(0.5)	0.5	0.93	20.37	0.58	10.98
GN1-MAPI(1)	1	0.94	21.55	0.65	13.17
GN1-MAPI(1.5)	1.5	0.91	21.94	0.62	12.37
NiO-MAPI	1	0.92	19.09	0.55	9.66
g-C ₃ N ₄ -MAPI	1	0.90	20.05	0.57	10.28

Table: S2 Photovoltaic parameters of forward and reverse J-V curves of MAPI, GN1-MAPI, GN2-MAPI, GN3-MAPI and GN4-MAPI based PSC

Perovskite Solar cells	Amount of NiO- g-C ₃ N ₄ (mg/mL)	Scan direction	V _{oc} (V)	J _{sc} (mA/cm ²)	FF	PCE (%)	Hysteresis
CH ₃ NH ₃ PbI ₃	-	Forward	0.83	18.30	0.43	6.53	2.05
		Reverse	0.87	18.62	0.53	8.58	
GN1-CH ₃ NH ₃ PbI ₃	1	Forward	0.93	21.35	0.61	12.11	0.08
		Reverse	0.94	21.52	0.64	13.15	
GN2-CH ₃ NH ₃ PbI ₃	1	Forward	0.96	21.76	0.66	13.78	0.06
		Reverse	0.96	22.55	0.68	14.72	
GN3-CH ₃ NH ₃ PbI ₃	1	Forward	0.90	20.83	0.53	9.94	0.13
		Reverse	0.90	21.20	0.59	11.45	
GN4-CH ₃ NH ₃ PbI ₃	1	Forward	0.93	19.85	0.54	9.97	0.14
		Reverse	0.94	20.17	0.61	11.56	

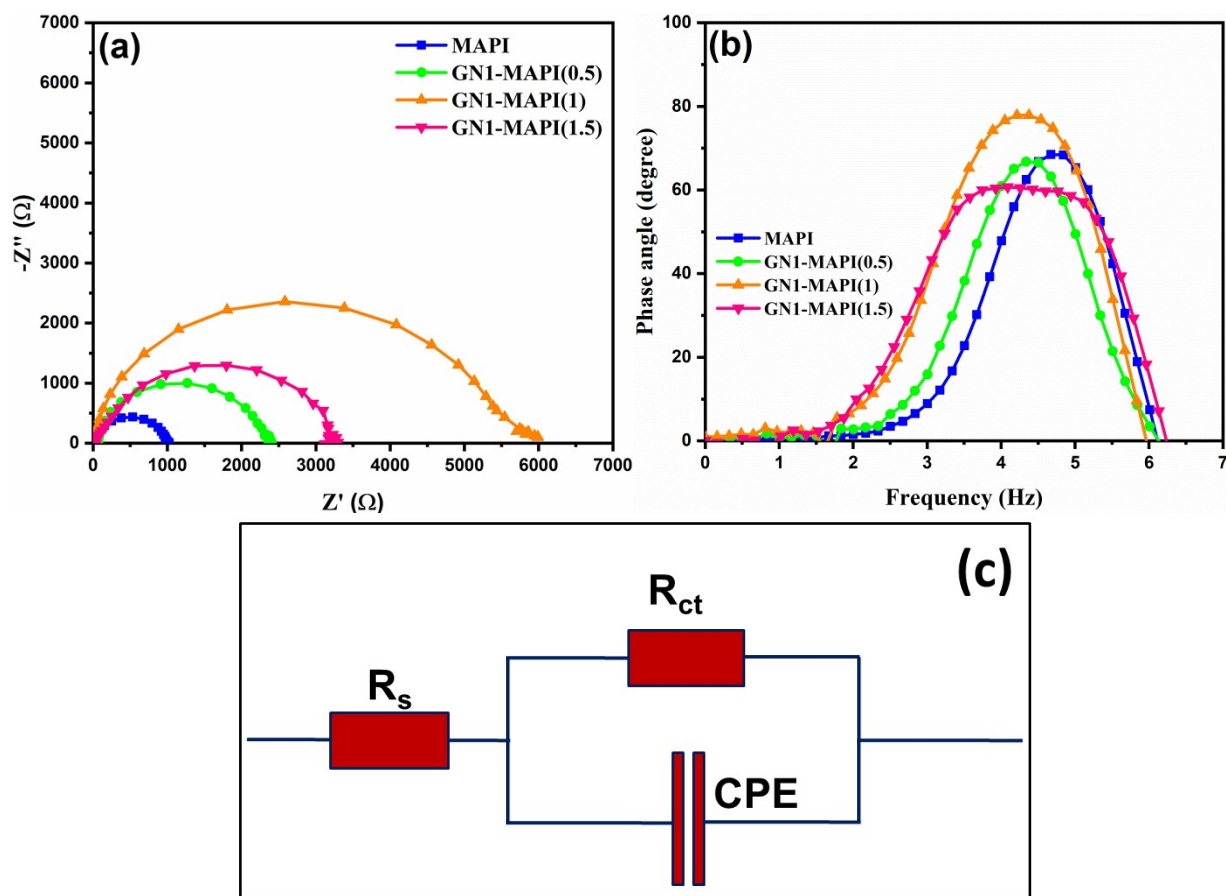


Fig.S8. EIS spectra of MAPI, GN1-MAPI(0.5), GN1- MAPI(1) and GN1- MAPI(1.5) based PSCs a) Nyquist plot, b) Bode plot and c) equivalent circuit model

Table: S3. EIS values of MAPI, GN1-MAPI(0.5), GN1-MAPI(1) and GN1- MAPI(1.5) based PSCs

Perovskite Solar cells	R_s (Ω)	R_{ct} (Ω)	CPE (nF)	Lifetime (μ s)
MAPI	25.61	961	31.57	33.45
GN1-MAPI(0.5)	68.45	2234	18.93	36.10
GN1-MAPI(1)	27.33	5414	16.70	37.03
GN1-MAPI(1.5)	29.35	2921	21.79	36.61

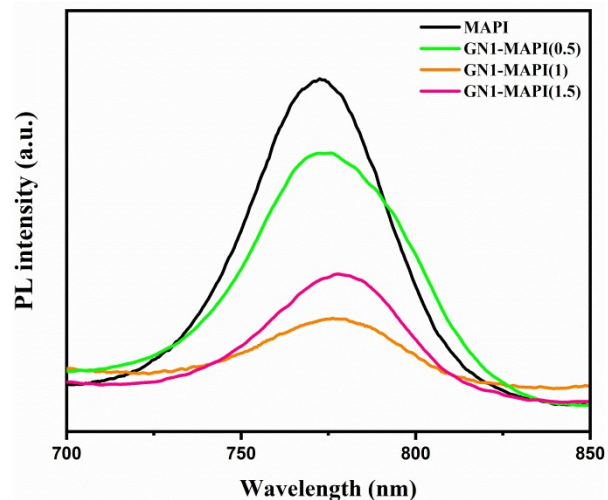


Fig.S9. Steady state PL spectra of MAPI, GN1-MAPI(0.5), GN1- MAPI(1) and GN1- MAPI (1.5) layer

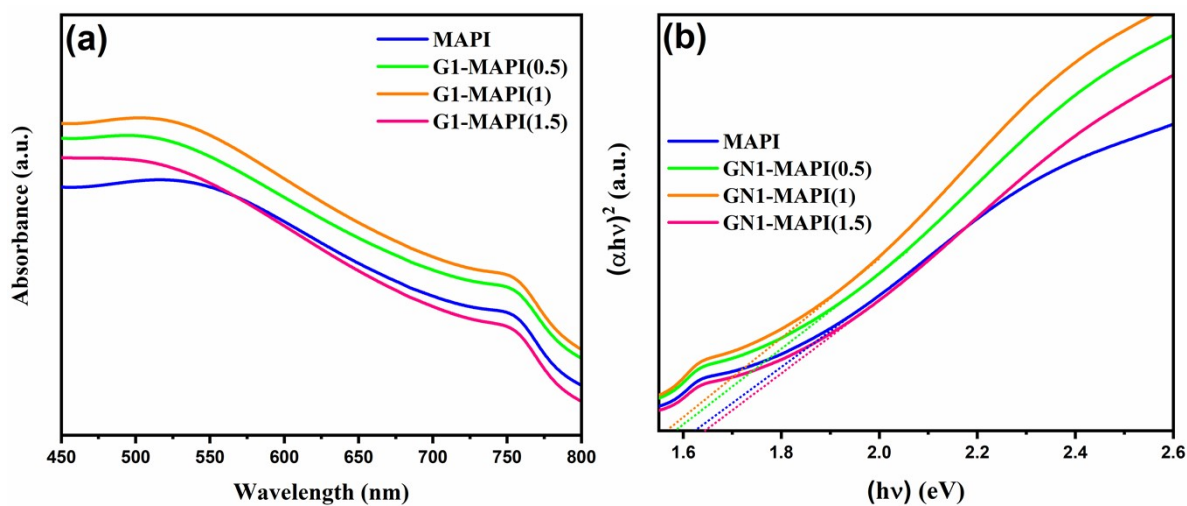


Fig.S10. UV-Vis spectra of MAPI, GN1-MAPI(0.5), GN1- MAPI(1) and GN1- MAPI (1.5) layer a) absorbance spectra and b) Tauc plot.

Table: S4. Band gap of MAPI, GN1-MAPI(0.5), GN1- MAPI(1) and GN1-MAPI(1.5), GN1-MAPI, GN2- MAPI, GN3- MAPI and GN4- MAPI layer

Sample	Band gap (eV)
MAPI	1.625
GN1-MAPI(0.5)	1.588
GN1-MAPI(1)	1.567
GN1-MAPI(1.5)	1.645
GN1- MAPI	1.567
GN2- MAPI	1.552
GN3- MAPI	1.606
GN4- MAPI	1.590