Supporting Information

Iodine-doped graphite carbon nitride for enhancing photovoltaic device performance via passivation trap states of triple cation perovskite films

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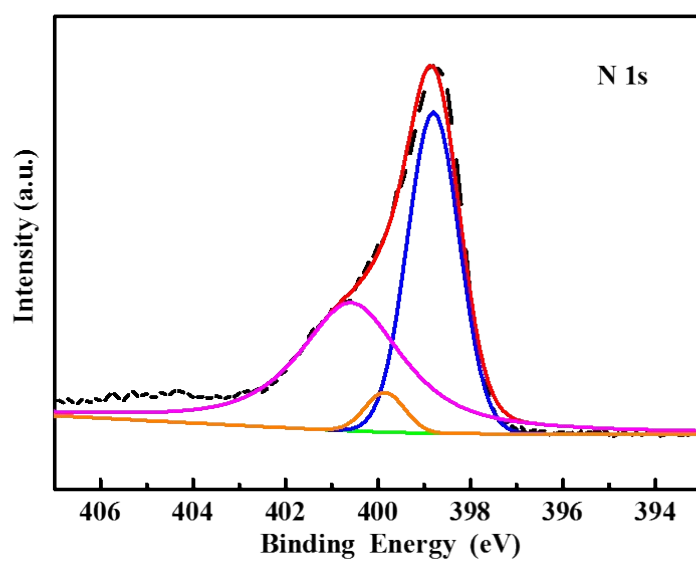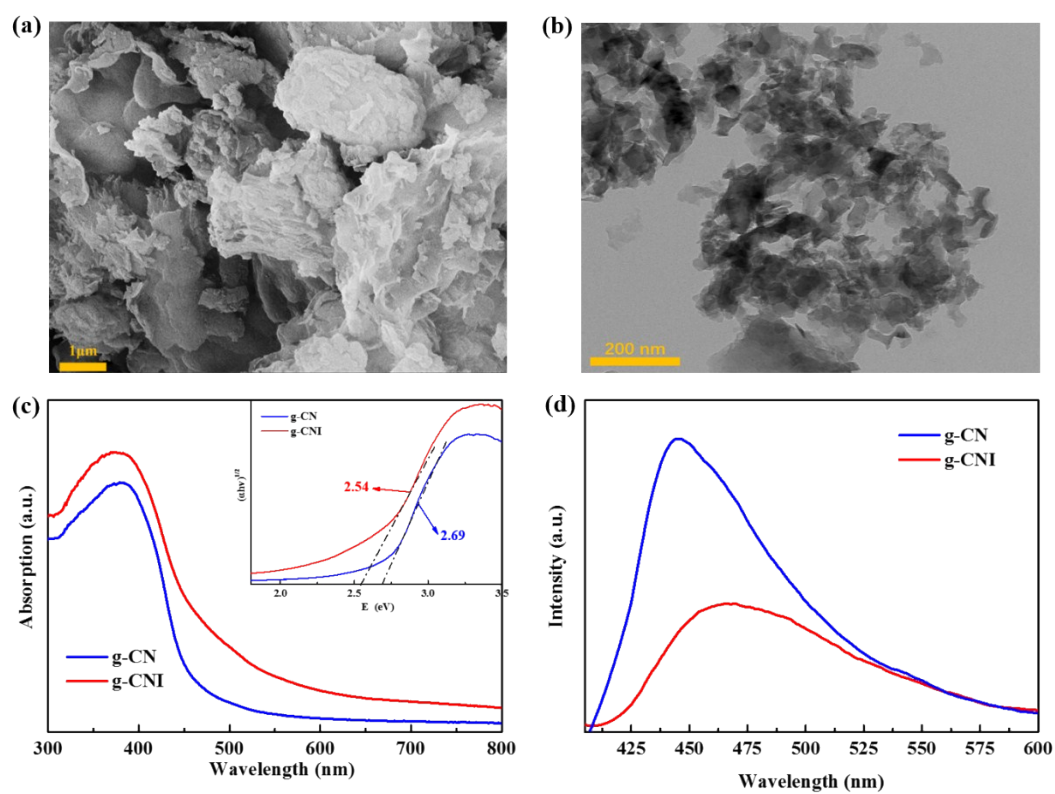
Fig. S1 XPS spectrum of N 1s for g-CNI.

Fig. S2 (a) SEM and (b) TEM images of g-CNI. (c) UV-vis absorption spectra of g-CNI and g-CN. The inset plots are the bandgap of the two samples. (d) PL spectra of g-CN and g-CNI.
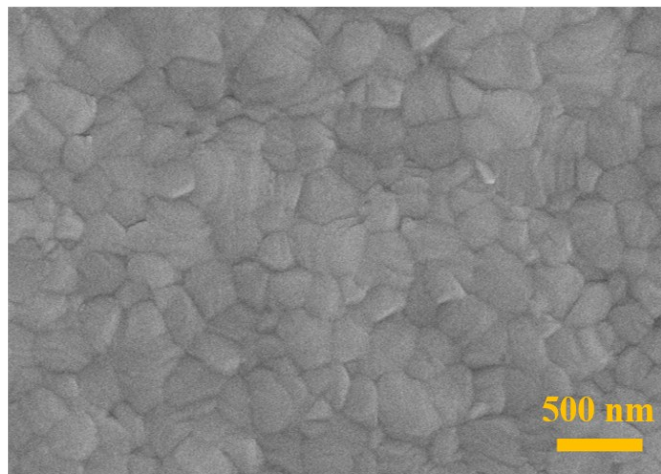
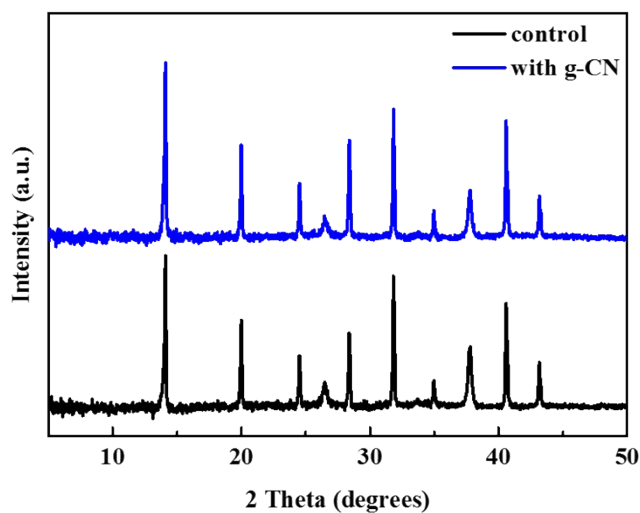**Fig. S3.** The top-view SEM image of the perovskite with g-CN.

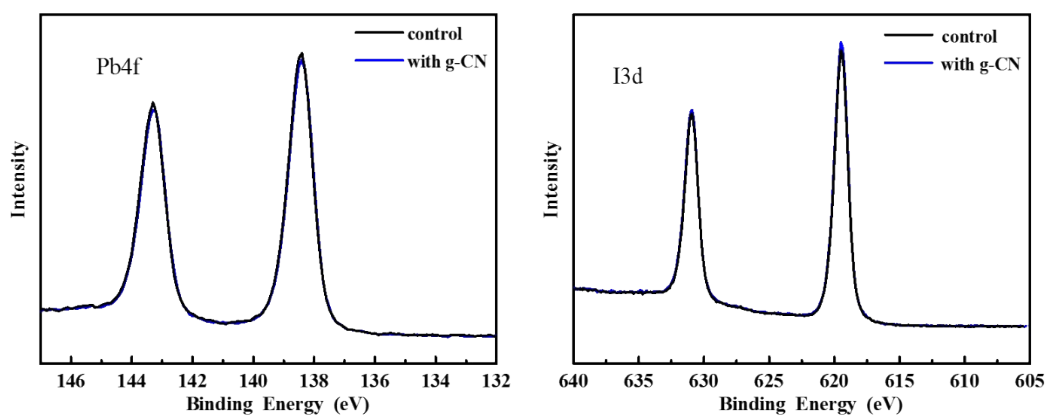**Fig. S4.** XRD patterns of perovskite with g-CN and the control

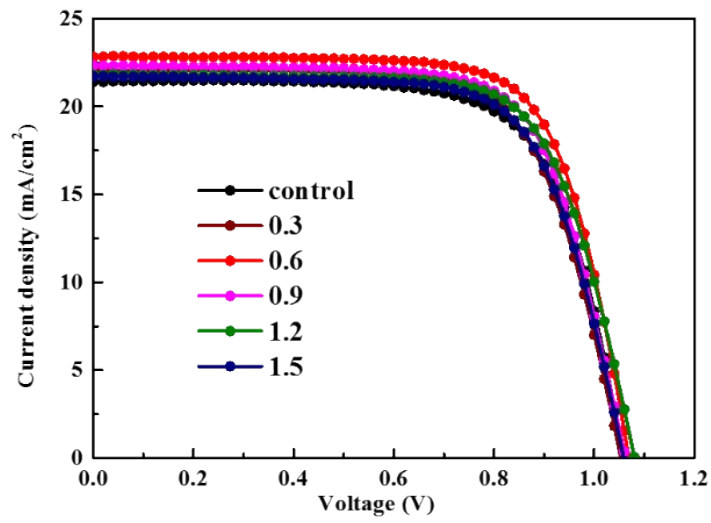**Fig. S5.** XPS spectra of I 3d (e) and Pb 4f (f) of perovskite films with g-CN.

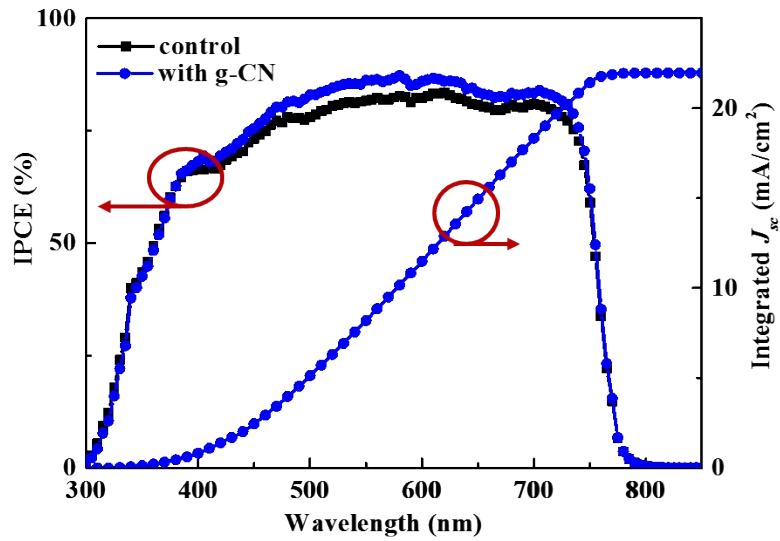**Fig. S6.** *J-V* curves of the devices of perovskite with g-CN with different addition amount.

Fig. S7. IPCE and corresponding integrated J_{sc} of the control and perovskite with g-CN devices
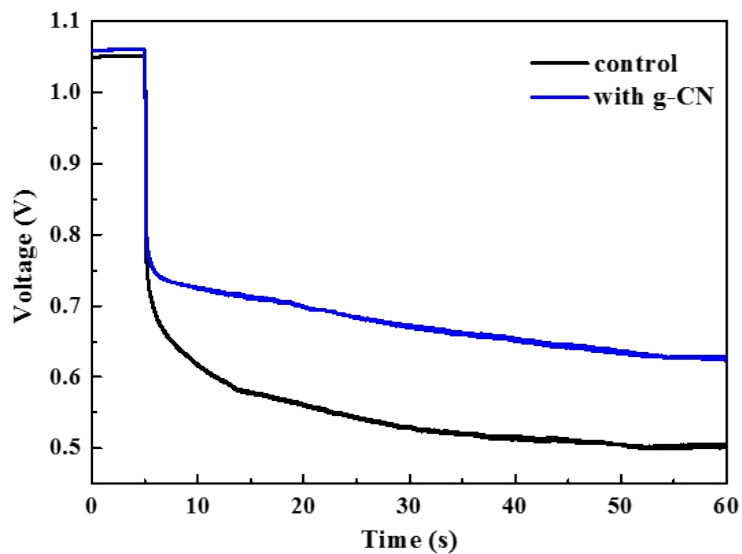
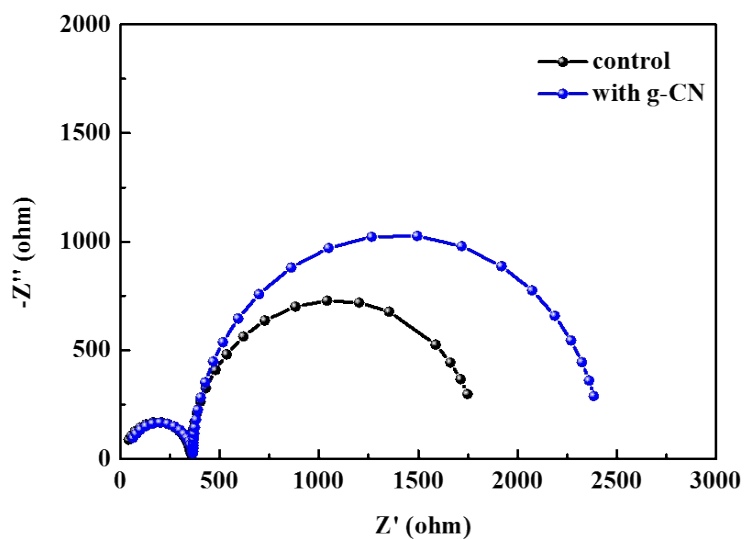**Fig. S8.** OCVD curves of the control and perovskite with g-CN devices.

Fig. S9. Nyquist plots of the control and perovskite with g-CN devices.
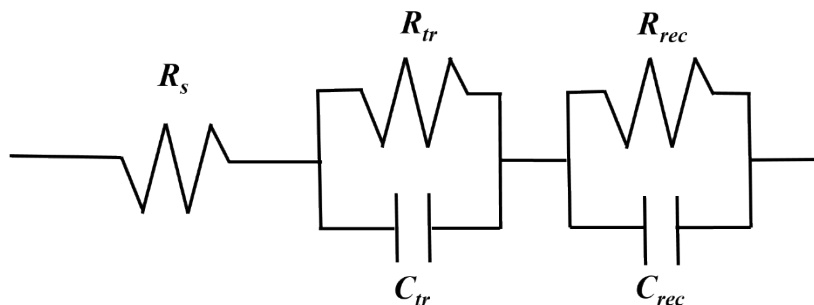

Fig. S10. The equivalent circuits for fitting Nyquist plots

Table S1. Fitted parameters of TRPL curves for the different perovskite films.

Device type	τ_1 (ns)	A_1 (%)	τ_2 (ns)	A_2 (%)	τ_{avg}
control	0.67	75.36	5.08	24.64	3.81
with g-CNI	0.70	73.33	6.98	26.67	5.62
with g-CN	0.71	73.53	6.87	26.47	5.49

The average carrier PL lifetime (τ_{avg}) is calculated by using the equation of $\tau_{avg} = (A_1*\tau_1{}^2 + A_2*\tau_2{}^2)/(A_1*\tau_1 + A_2*\tau_2)$.

Table S2. The photovoltaic parameters of the perovskite with g-CNI in the different doping ratio.

Device type	J_{sc} (mA/cm^2)	V_{oc} (V)	FF	PCE (%)
control	21.45	1.06	0.70	15.93
0.3	22.05	1.05	0.70	16.29
0.6	22.80	1.07	0.72	17.66
0.9	22.28	1.06	0.71	16.86
1.2	22.02	1.06	0.71	16.59
1.5	21.68	1.06	0.71	16.20

Table S3. The R_s, R_{tr}, R_{rec} of the devices with g-CNI, with g-CN and the control.

Device type	R_S	R_{tr}	R_{rec}
control	16.04	337.3	1459
with g-CN	32.92	331.8	2061
with g-CNI	19.21	322.7	3545