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Supporting Information

In situ polymerization of graphene-polyaniline@ polyimide nanocomposite films with high EMI shielding and electrical properties

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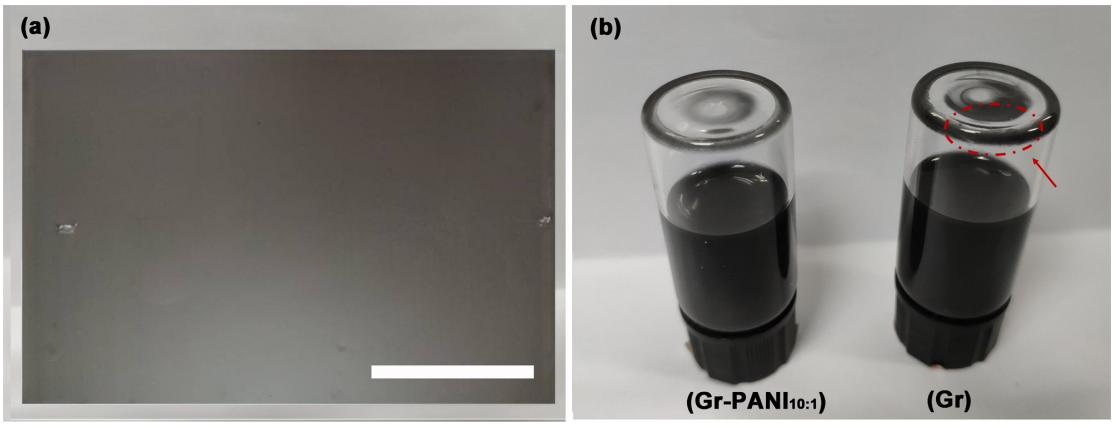

Fig. S1 (a) The large size 40%Gr-PANI$_{10:1}$@PI film (the scale bar is 10 cm); (b) Gr-PANI$_{10:1}$ in NMP and Gr in NMP.

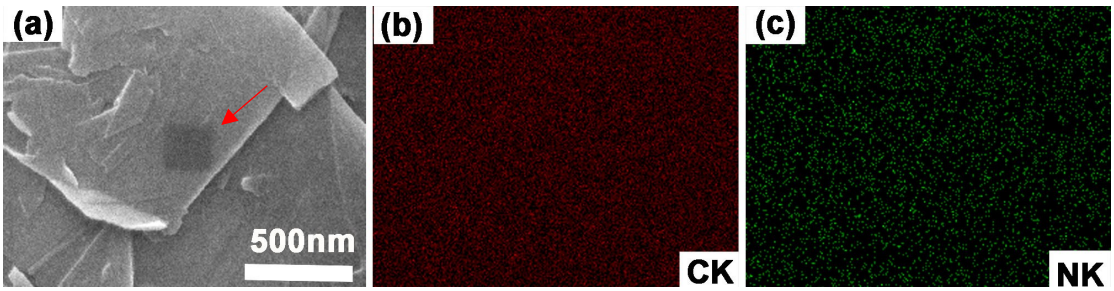

Fig. S2. SEM image of Gr-PANI$_{10:1}$ and the EDS mapping of Gr-PANI$_{10:1}$.

Table S1 Element content of Gr-PANI$_{10:1}$ composites.

Element (Gr-PANI$_{10:1}$)	At%
CK	77.15
NK	22.19
OK	00.66

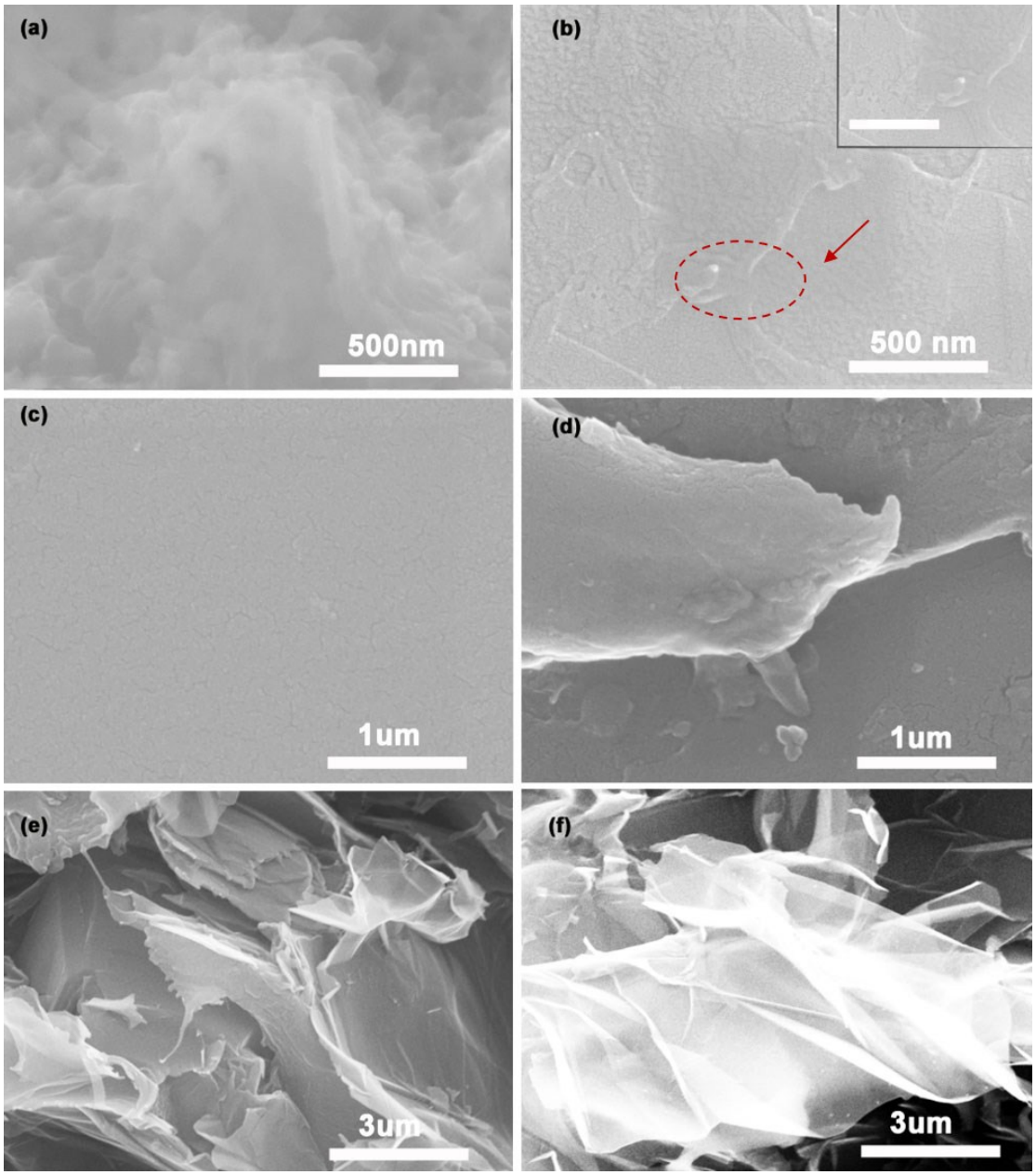

Fig. S3 The SEM images of (a, b,c,d) surface morphology of PANI, Gr-$PANI_{5:1}$,Gr-$PANI_{10:1}$@PI and PI; The cross-section images (e, f) of Gr@PI and Gr-$PANI_{10:1}$@PI; The inset shows the magnification of the selected area and the scale bar is 0.1 um.

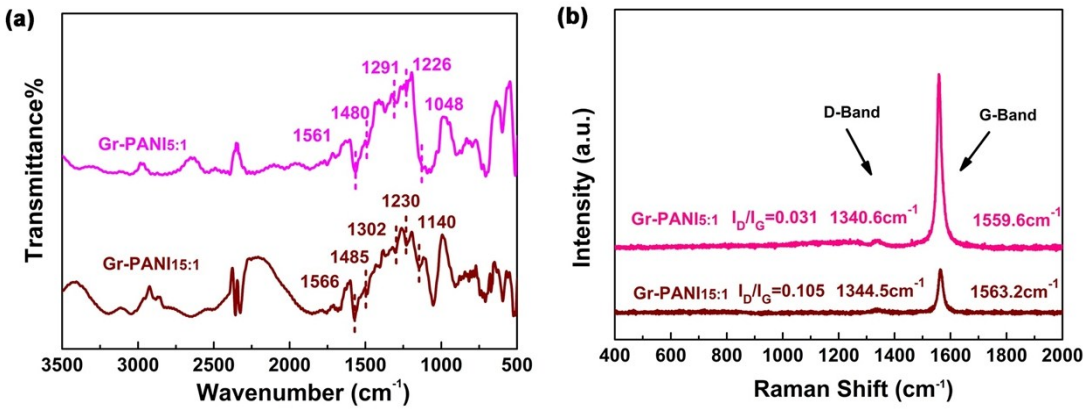

Fig. S4 (a) FTIR spectra of Gr-PANI$_{5:1}$ and Gr-PANI$_{15:1}$ composites; (b) Raman spectra of Gr-PANI$_{5:1}$ and Gr-PANI$_{15:1}$ composites.

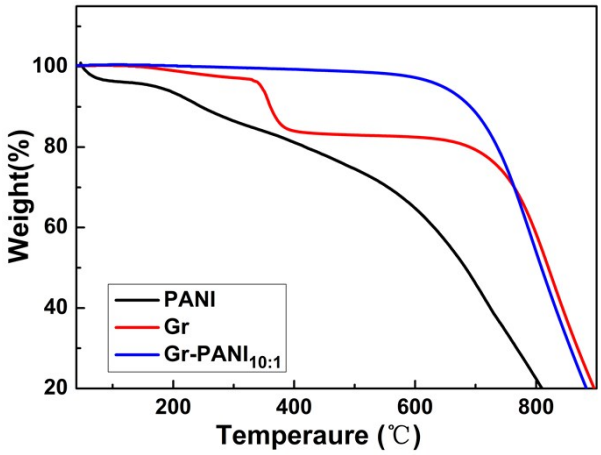

Fig. S5 TGA curves of pure PANI, Gr and Gr-PANI$_{10:1}$ composites.

Fig. S5 shows TGA curves of pure PANI, Gr and Gr-PANI$_{10:1}$ composites. The 15 wt% weight loss temperatures of the PANI, Gr and Gr-PANI$_{10:1}$ are 328.5 ℃, 383.1 ℃, and 717.5℃, respectively. Meanwhile, the residual weight at 700 ℃ for the Gr-PANI$_{10:1}$ is remarkably enhanced from 79.3% (pure Gr) to 86.8%, indicating that the Gr-PANI$_{10:1}$ shows superior thermal stability. The TGA curve of Gr-PANI$_{10:1}$ is the superposition of Gr and PANI. The weight ratio of PANI in Gr-PANI$_{10:1}$ is calculated by the following equation (1):

$$\text{wt\%(PANI)} = 1 - \frac{\Delta W2 - \Delta W1}{\Delta W2 - \Delta W3} \times 100\% \quad (1)$$

where the ΔW_1, ΔW_2 and ΔW_3 represent the weight loss of Gr-PANI$_{10:1}$, PANI and Gr from 40 to 800 °C. According to the TGA data, the PANI content in Gr-PANI$_{10:1}$ is 12.5 wt%, which is close to the theoretical value.

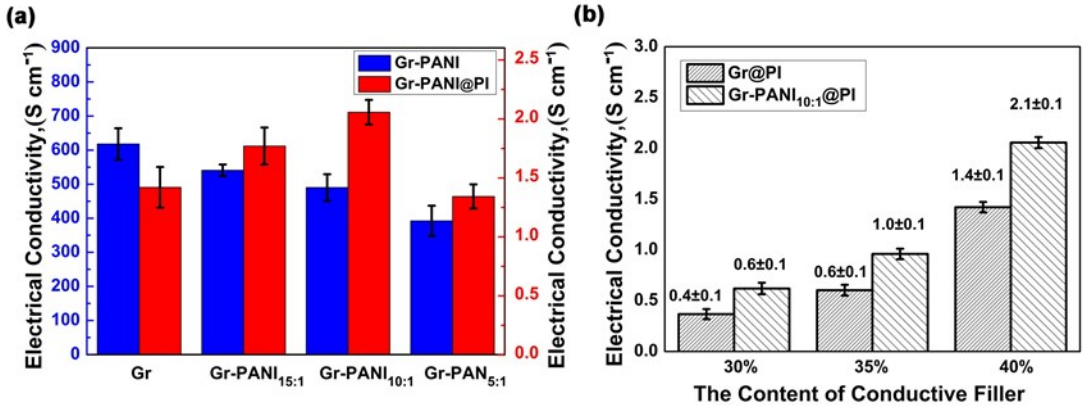

Fig. S6 Electrical conductivity of (a) Gr-PANI and 40%Gr-PANI@PI with different mass ratios of Gr to PANI; (b) Gr@PI and Gr-PANI$_{10:1}$@PI with different filler contents.

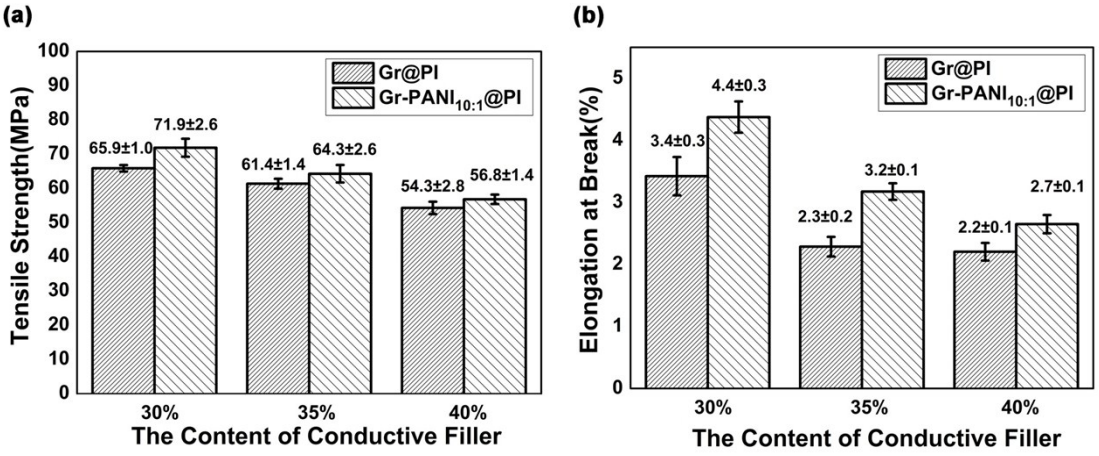

Fig. S7 The mechanical properties of Gr@PI and Gr-PANI$_{10:1}$@PI with different filler contents (a) the tensile strength; (b)the elongation at break.

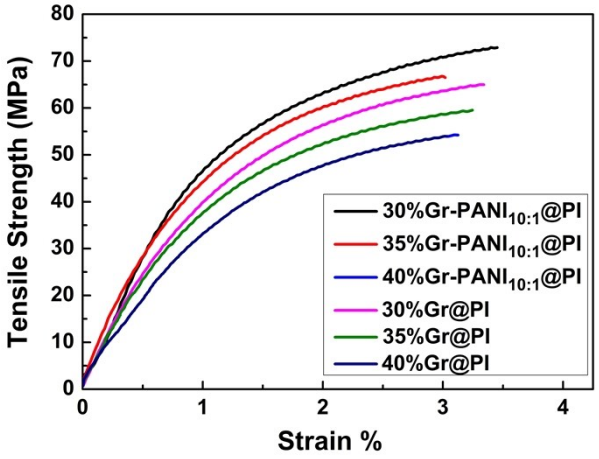

Fig. S8 Typical stress–strain curves of pure Gr@PI and Gr-PANI$_{10:1}$@PI films with different filler contents.

Fig. S9 Experiment setup for EMI shielding measurement: vector network analyzer.

Table S2 EMI shielding performance of various carbon-based polymer composite films

Materials	Content (wt%)	Thickness (mm)	EMI SE_T (dB)	EMI SSE value ($dB \cdot cm^2 g^{-1}$)	Ref
PS/graphene	30.0	2.50	~17.3	~256.3	[1]
PEI/graphene foam	10.0	2 .30	~11.0	~164.9	[2]
PU/MWCNT	22.0	0.10	~20.0	/	[3]
WPU/CNT	76.2	0.32	~49.0	~3408.0	[4]
PVDF/graphene	15.0	0.10	/	~1265.0	[5]
Phenolic/rGO	70.0	0.30	~43.4	/	[6]
PI/graphene	8.0	0.50	13.7–14.9	~693.0	[7]
PI/graphene foam	16.0	0.80	17.0-21.0	~`75.0	[8]
PE/graphene	15.0	1.00	~33.0	/	[9]
Cellulose/CNT	40.0	0.15	~35.0	~1372.4	[10]
WPU/CNT	76.2	2.30	~35.0	~2143.0	[11]
Gr-$PANI_{10:1}$@PI	40.0	0.04	~21.3	~4096.2	This work

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