Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Supporting Information

Enhanced electromagnetic interference shielding behavior of graphene nanoplatelet/Ni/Wax nanocomposites

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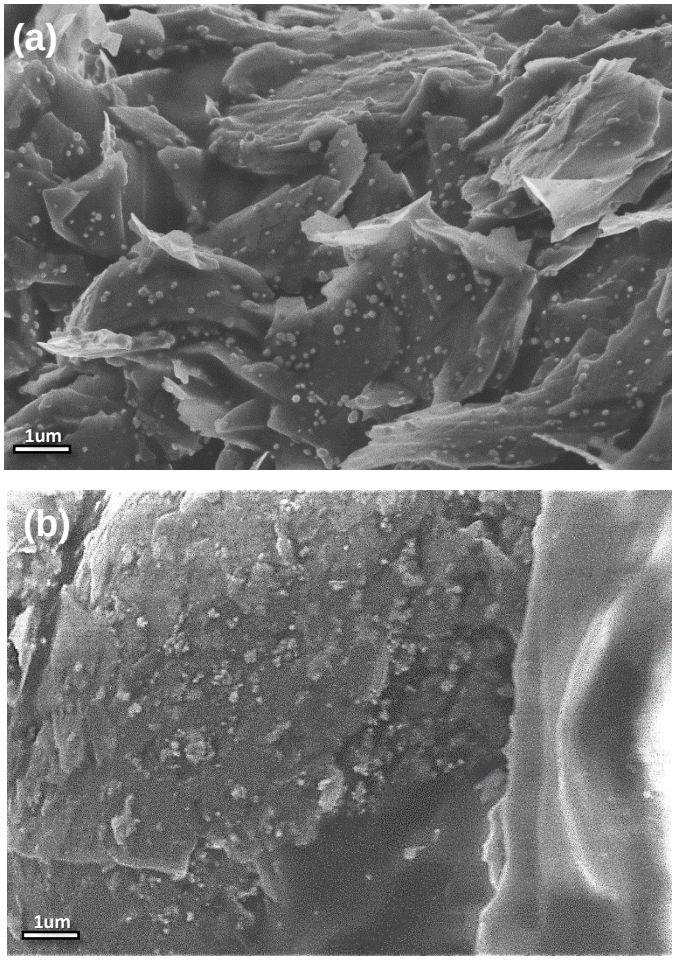

Fig. S1 Scanning electron microscopy (SEM) images of GNP/Ni/wax containing (a) GNP/Ni (M) and (b) GNP/Ni (B).

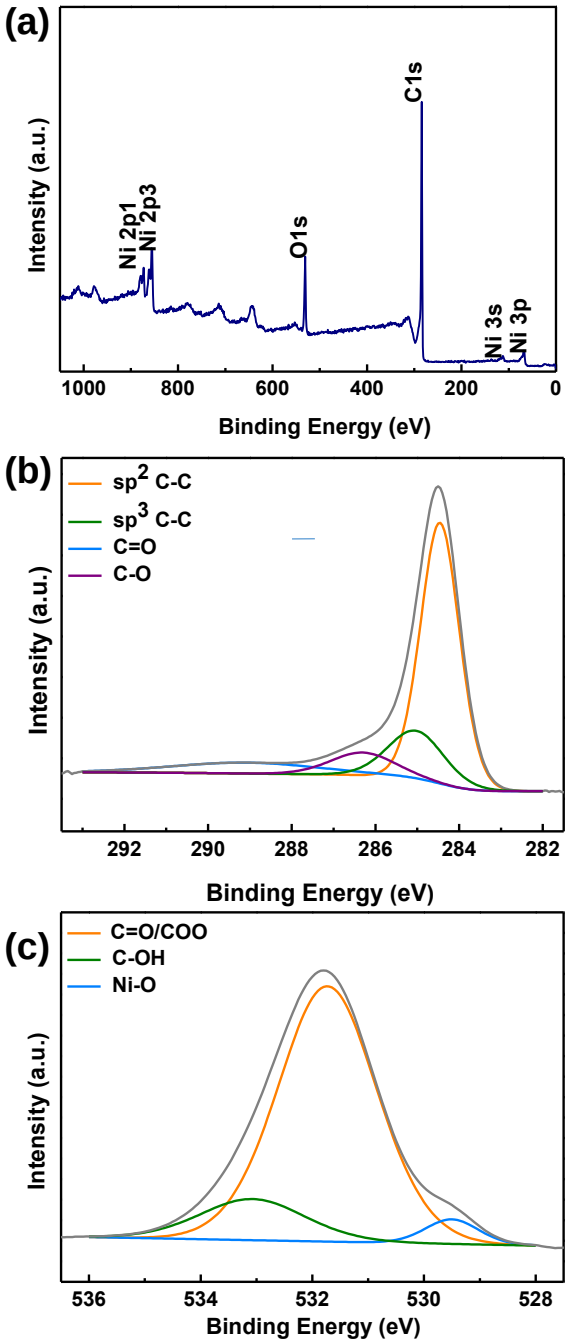

Fig. S2 (a) Survey scans for XPS spectra of GNP/Ni (B). (b) C 1s spectra of GNP/Ni (B). (c) O 1s spectra of GNP/Ni (B).

Table S1 List of functional groups and their relative atomic percentage in C 1s and O 1s peaks of GNP/Ni (M) and GNP/Ni (B) nano-sized powders.

		Functional groups (relative atomic percentage [%])				
GNP/Ni (M)	C 1s peaks	sp^2 C-C (65.36at%)	C-OH (12.42at%)	C=O (9.80at%)	C-O (8.50at%)	C-Ni (3.92at%)
	O 1s peaks	C=O/COO (49.26at%)	C-OH (37.93at%)	Ni-O (7.39at%)	Ni-O-C (5.42at%)	
GNP/Ni (B)	C 1s peaks	sp^2 C-C (63.69at%)	sp^3 C-C (17.20at%)	C=O (10.19at%)	C-O (8.92at%)	
	O1s peaks	C=O/COO (81.97at%)	C-OH (13.93at%)	Ni-O (4.10at%)		

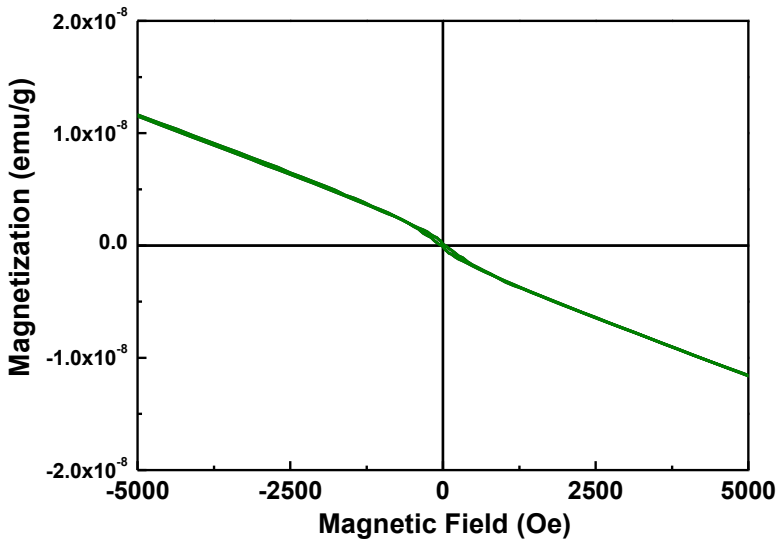

Fig. S3 Plot of magnetization versus magnetic field for GNP at room temperature.

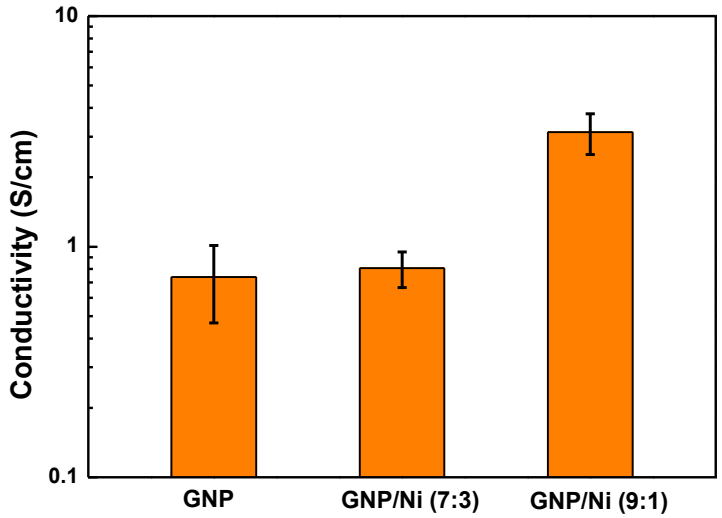

Fig. S4 Log electrical conductivities of wax nanocomposites filled with GNP and GNP/Ni nanocomposites (volume ratio of 7:3 and 9:1) (30 wt.%)

Experimental

1. Fabrication of RGO/Ni nanocomposites

The typical process includes two steps.

(1) Synthesis of GO powders

GO were synthesized from natural graphite by the Hummers' method.[1] Graphite (1 g) and H_2SO_4 (40 mL) were mixed through stirring in an ice bath. $KMnO_4$ (3.5 g) was slowly added as an oxidizing agent to the solution. After stirring, DI water was added slowly to this as the oxygen source. Then, H_2O_2 (10 mL) was added to remove Mn ions. This solution was filtered and rinsed with a HCl solution to remove the residual. GO powders were obtained after drying under vacuum.

(2) Fabrication of RGO/Ni by the molecular-level mixing process

Fabrication process of RGO/Ni is the same with that of GNP/Ni by the molecular-level mixing process. GO (500 mg) was dispersed in ethylene glycol (500 ml) by ultra-sonication for 2 hours. Ni(CH3CO2)2·(H2O)4 (0.966 g) was added and mixed with the GO solution (volume ratio of RGO/Ni about 9:1). Then, aqueous 2M NaOH (5 ml) was added to the solution and the mixed solution was heated to 60°C. Subsequently, hydrazine monohydrate (5 ml) was introduced under continuous heating at 60°C. After cooling the mixture, it was filtered and rinsed with ethanol. The powders were dried at 80°C under vacuum and completely reduced into RGO/Ni powders at 400°C for 3 hours under hydrogen atmosphere.

2. Fabrication of RGO powders[2]

GO powders were dispersed in DI water (3mg/ml) by sonicating for 2 hours. Hydrazine monohydrate (1ul for 3mg of GO) was subsequently added to the GO solution. Additional stirring in an oil bath was held at 80°C for 12 hours. This process results in black reduced graphene oxide powder. After cooling to room temperature, the powders were filtered and dried under vacuum.

References

1. W. S. Hummers and R. E. Offeman, *J. Am. Chem. Soc*. 1958, **80**, 1339−1339.
2. S. Park, J. An, J. R. Potts, A. Velamakanni, S. Murali and R. S. Ruoff, *Carbon*, 2011, **49**, 3019–3023.

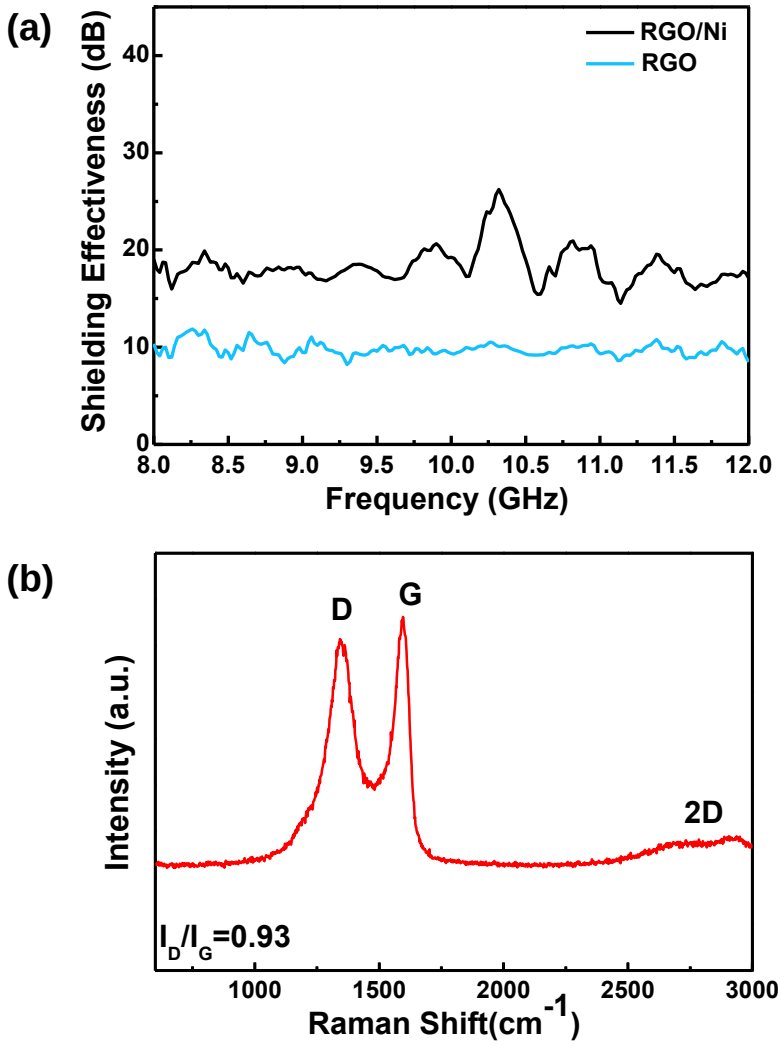

Fig. S5 (a) EMI shielding effectiveness of wax nanocomposites filled with RGO and RGO/Ni (30 wt.%) with 0.7 mm in thickness from 8 to 12 GHz. (b) Raman spectra of RGO/Ni.

Table S2 Electrical conductivities and EMI SE values of GNP, RGO, and their nanocomposites at 8 and 12 GHz.

30wt% in wax	Conductivity (S/cm)	EMI SE (dB)	
		8 GHz	12 GHz
GNP	0.73916 ± 0.2724	27.705	23.947
GNP/Ni (M)	3.1390 ± 0.6278	38.552	37.4
RGO	0.07536 ± 0.01613	10.335	8.468
RGO/Ni (M)	0.22382 ± 0.08902	19.035	17.117