# Supporting Information

## Flexible, Multifunctional and Thermally Conductive Nylon/Graphene Nanoplatelet Composite Papers with Excellent EMI Shielding Performance, Improved Hydrophobicity and Flame Resistance

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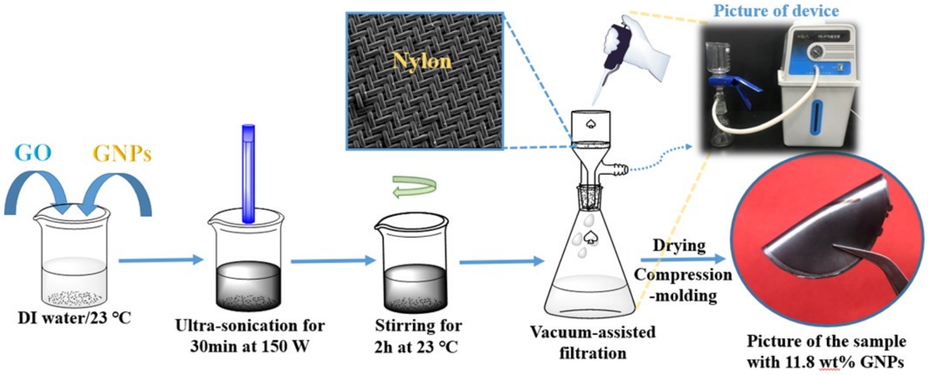


**Figure S1**. Schematic illustration of the fabrication of nylon/GNP composite papers

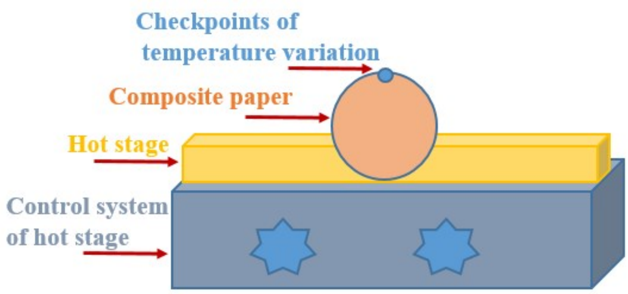


**Figure S2**. The schematic diagram of heating composite papers.

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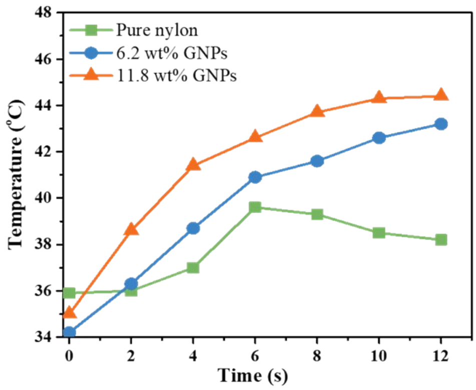


**Figure S3.** Temperature variation of top part of composite papers with increasing heating time.

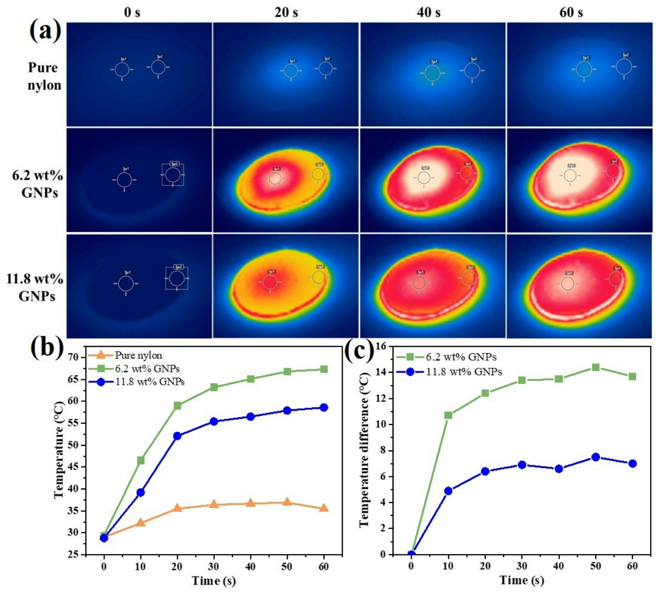


**Figure S4.** Infrared thermal images of composite papers when exposed to infrared light (a), the temperature variation of center zone (b) and the temperature differences between center zone and edge of composite paper samples as time increases (c).

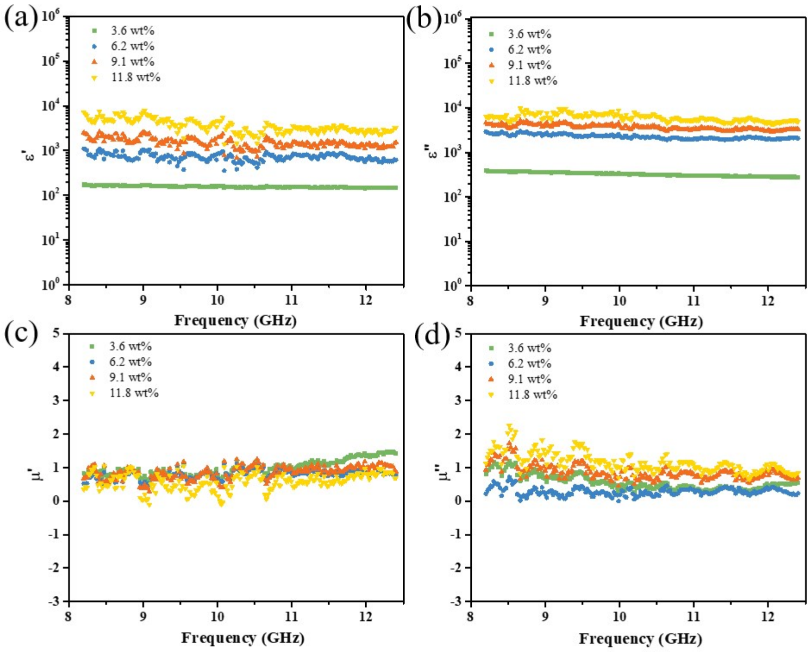


**Figure S5.** Electromagnetic parameters of composite papers: (a) the real part of complex permittivity, (b) the imaginary part of complex permittivity, (c) the real part of complex permeability, and (d) the imaginary part of complex permeability.

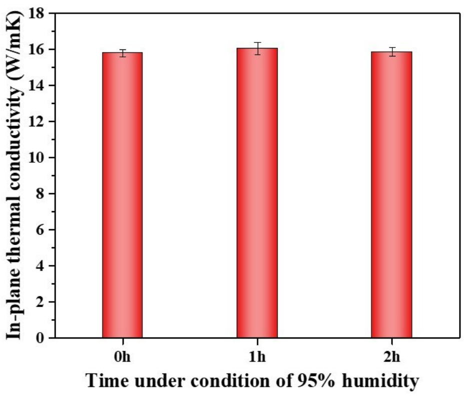


**Figure S6.** Comparison of in-plane thermal conductivity when composite papers with 11.8 wt% GNPs was placed under condition of 95% humidity.

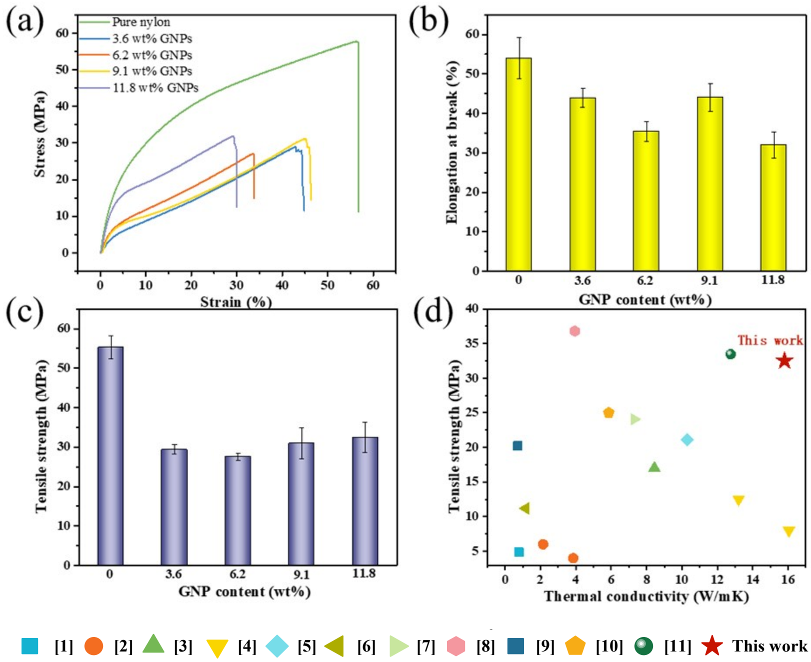


**Figure S7.** Mechanical properties of the composite papers. The composite papers had three layers of nylon gauzes and GNP, and the concentration ratio between GO and GNPs was maintained at 2:4. (a) Stress-strain curves, (b) elongation at break, (c) tensile strength, and (d) comparison of tensile strength and thermal conductivities between the composite papers obtained in this work and the others as reported in literature.[1-11]

**Table S1.** The component contents of the nylon composite papers.

| *GO/GNPs* | *Content of nylon (wt%)* | *Content of GO (wt%)* | *Content of GNPs (wt%)* |
|---|---|---|---|
| 2:4 | 94.6 | 1.8 | 3.6 |
| 2:4 | 90.7 | 3.1 | 6.2 |
| 2:4 | 86.35 | 4.55 | 9.1 |
| 2:4 | 82.3 | 5.9 | 11.8 |
| 1:4 | 92.25 | 1.55 | 6.2 |
| 3:4 | 89.15 | 4.65 | 6.2 |

**Table S2.** Comparison of the thermal conductivities and filler contents used to achieve the performance between the composites obtained in this work and the other composites reported in literature. [a]

| *Composites* | *In-plane thermal conductivity (W/mK)* | *Out-plane thermal conductivity (W/mK)* | *Filler content* | *Testing method* | *Year and references* |
|---|---|---|---|---|---|
| NR/rGO-BN | 16.044 | 0.865 | ~69wt%BNs | LFA-467 | 2020[4] |
| NFC/NDs-GS | 14.35 | 0.18 | 10 wt% | LFA-447 | 2020[12] |
| NFC/BN | 20. 64 | 0.5 | 40 wt% | LFA-467 | 2020[13] |
| CNF/CPGO | 12.75 | 0.28 | 70 wt% | LFA-467 | 2020[11] |
| PVDF/BNNS | 16.3 | 0.78 | 33 wt% | LFA-467 | 2019[14] |
| Epoxy/BNNS | 6.54 | 0.7 | 20 vol% | TPS2500 S | 2019[15] |
| ANF/BNNSs@PDA | 3.94 | 0.62 | 50 wt% | TPS2200 | 2020[8] |
| PDMS/BN | 11.05 | 1.15 | 16 wt% | LFA-467 | 2019[16] |
| CNF/$MoS_2$@SiCNW | 19.76 | 0.68 | 40 wt% | LFA-467 | 2020[17] |
| PVA/graphene | 13.8 | 0.6 | 10 wt% | LFA-447 | 2020[18] |
| CNF/OH-BNNS | 15.13 | -- | 50 wt% | LFA-447 | 2020[19] |
| NFC/PEG/graphene | 21.83 | -- | 30 wt% | LFA-447 | 2019[20] |
| **Nylon/GNP** | **15.8** | **0.66** | **11.8wt%GNPs** | **TPS2200** | **This work** |

a. NR: natural rubber; NFC: nanofibrillated cellulose; CNF: cellulose; PVDF: polyvinylidene fluoride; ANF: aramid nanofiber; PDMS: polydimethylsiloxane; -- indicates that the values were not available.

**Table S3.** Comparison of thermal conductivities, EMI SE/thickness and filler contents used to achieve the performances between the nylon/GNP composite papers and other polymeric composite materials as reported in literature. [a]

| *Composites* | *Thermal conductivity (W/mK)* | *SE/thickness (dB/mm)* | *Filler content* | *Year and references* |
|---|---|---|---|---|
| PVDF/Ni-graphene | 6.81 | 66.75 | 20 wt% | 2020[21] |
| PVDF/SiC-graphene | 2.13 | 27.1 | 9.5 wt% | 2020[22] |

| | | | | |
|---|---|---|---|---|
| Epoxy/graphene | 8 | 45 | 50 wt% | 2018[23] |
| NR/CNT-BN | 0.25 | 22.4 | 18.1 wt% | 2020[24] |
| PS/Cu-Ag | 16.1 | 220 | 13 vol% | 2019[25] |
| PS/GNPs | 4.72 | 11 | 35 wt% | 2019[26] |
| Epoxy/RGO@$Fe_3O_4$ | 1.213 | 13.45 | 8.97 wt% | 2019[27] |
| PVDF/CNT-Ni | 0.65 | 95.5 | 7 wt% | 2018[28] |
| PVDF/GNP-Ni | 0.66 | 93 | 13 wt% | 2018[28] |
| WPU/cotton/RGO | 2.13 | 48.1 | 2 wt% | 2019[29] |
| MW/Nylon/ rGO-PEDOTs | 0.81 | 87.86 | -- | 2020[30] |
| PVDF/MXene | 0.767 | 24.235 | 22.55vol% | 2020[31] |
| PDMS/CNT | 2.52 | 88 | -- | 2020[32] |
| Cellulose/MXene | 3.89 | 215 | 1.07 vol% | 2020[33] |
| Epoxy/CNT-$Fe_3O_4$@Ag | 0.46 | 17.5 | 15 wt% | 2019[34] |
| Epoxy/ GNPs-rGO | 1.56 | 17 | 20.4 wt% GNPs | 2019[35] |
| CE/ GNSs- CINA | 4.13 | 15.7 | 20 wt% | 2018[36] |
| **Nylon/GNP** | **15.8** | **322.7** | **11.8 wt%** | **This work** |

a. PVDF: polyvinylidene fluoride; NR: natural rubber; PS: polystyrene; WPU: waterborne polyurethane; MW: merino wool; PDMS: polydimethylsiloxane; CE: Cyanate Este; CINA: carbonyl iron-nickel alloy; --indicates that the values were not available.

**Supplementary method S1: Finite Element Model**

A finite element model of electronic chip cooling was created through the COMSOL Multiphysics 5.5 software. The detailed simulation process of electronic chip cooling was according to the model suppled from COMSOL for free. According to experience, the convective heat flux was set as 10 W/($m^2$·K), and the ambient temperature and atmospheric pressure were 20 °C and 1 atm, respectively. Ideal contact means that there is no thermal resistance between chip and radiator. Obviously, there is always the contact gap. Specially, the contact gap can be modeled and the contact model between silica glass chip and aluminum radiator was set as equivalent thin resistive layer. Here, the layer thickness was set as 180 μm in this work. Air and thermal grease were chosen as the materials of contact model, respectively. Due to the character of equivalent thin resistive layer, the in-plane thermal conductivity is dominant whereas out-plane thermal conductivity is ignored. So, when nylon/GNP composites were defined as materials of contact model in this work, the layer thermal conductivity was set as 15.8 W/mK according to the thermal conductivity measurement of the composite papers.

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