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

Supporting Information

Highly Anisotropic Thermal and Electrical Conductivities of Nylon Composite Papers with the Integration of Strength and Toughness

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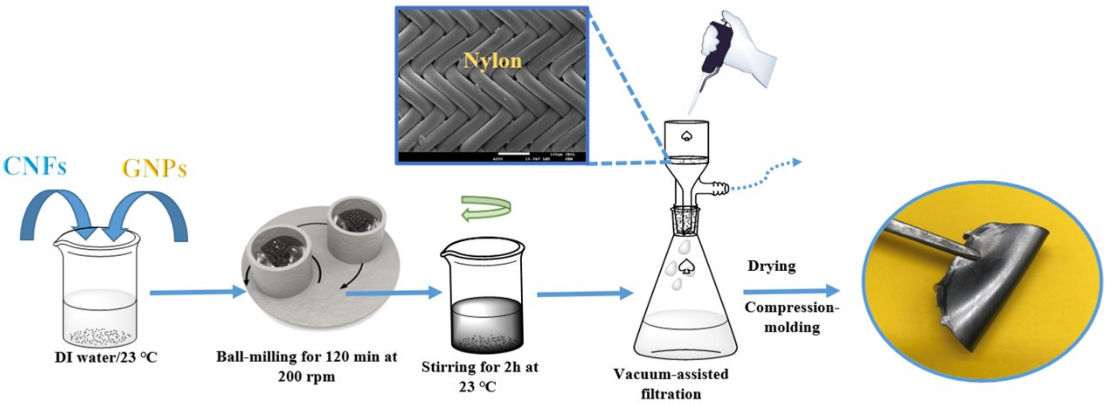

Fig. S1 The fabrication process of nylon composite papers by vacuum-assisted filtration and compression-molding.

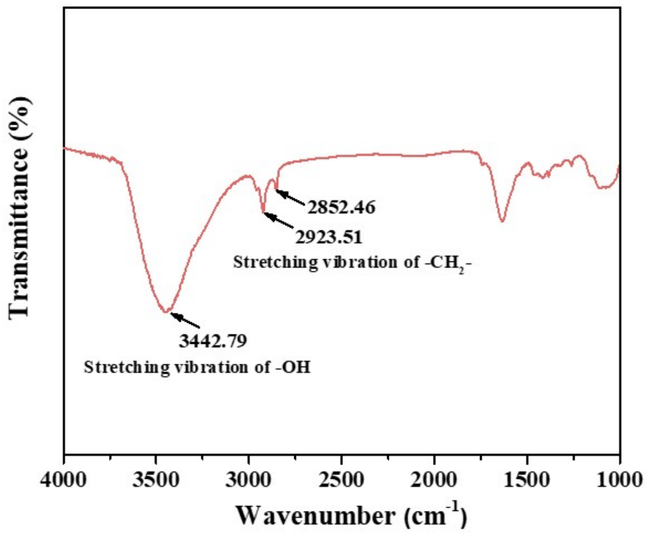

Fig. S2 FTIR spectrum of CNFs as purchased.

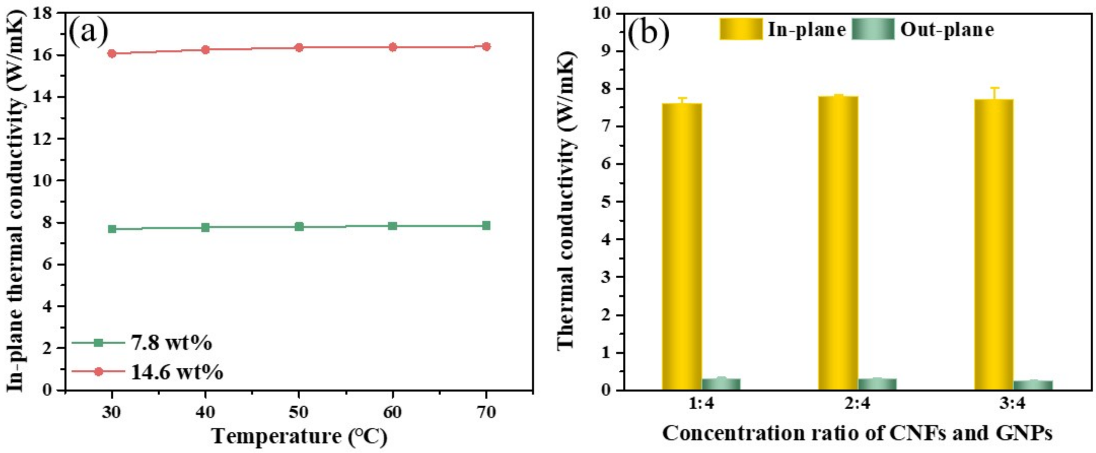

Fig. S3 (a) Variation of in-plane thermal conductivity of nylon composite paper under different temperatures, and (b) thermal conductivity of nylon composite papers filled with 7.8 wt% GNPs with varied concentration ratios of CNFs and GNPs as indicated.

Fig. S4 The viewing content of device screen when the electrical resistance is over the measuring range (100 MΩ).

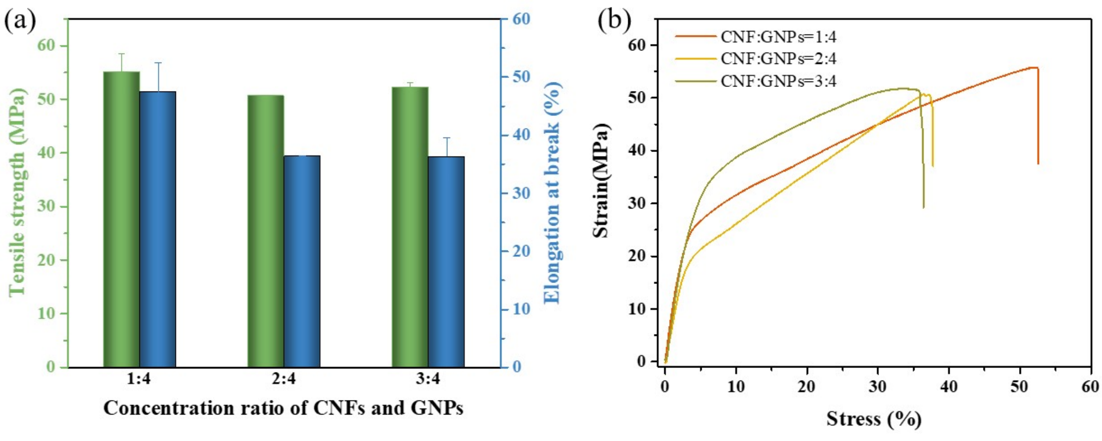

Fig. S5 Mechanical properties of nylon composite papers with 7.8 wt% GNPs and different concentration ratios of CNFs and GNPs in fabricating the composite papers. (a) Tensile strength and elongation at break, and (b) strain-stress curves.

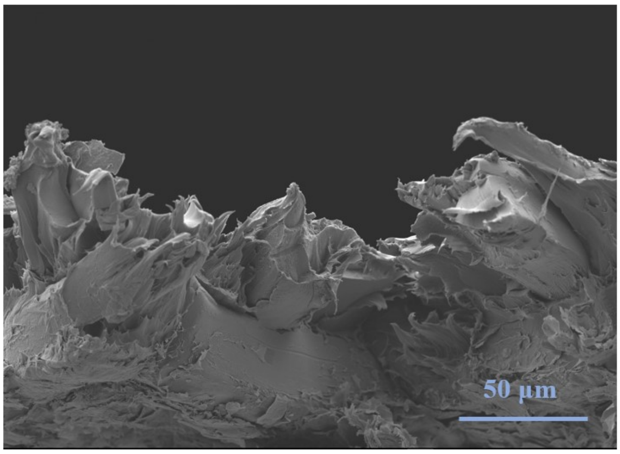

Fig. S6 Morphology of fractured surface of nylon composite paper after tensile test.

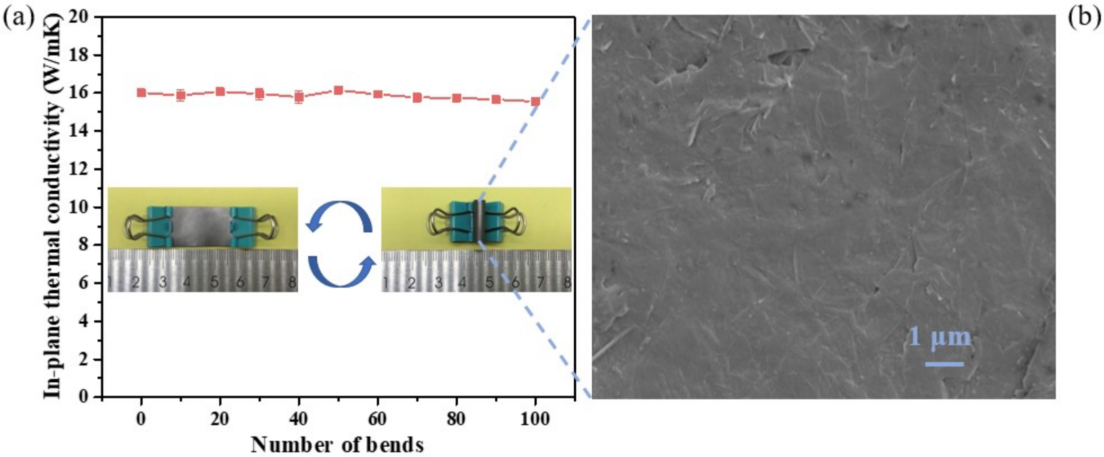

Fig. S7 (a) Variation of the in-plane thermal conductivity of nylon composite paper filled with 14.6 wt% GNPs with increasing number of bending tests, and (b) surface morphology of the sample after experiencing 100 times of bending tests.

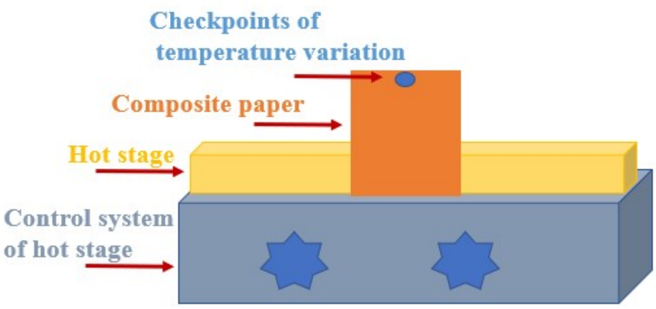

Fig. S8 The schematic diagram of heating nylon composite papers.

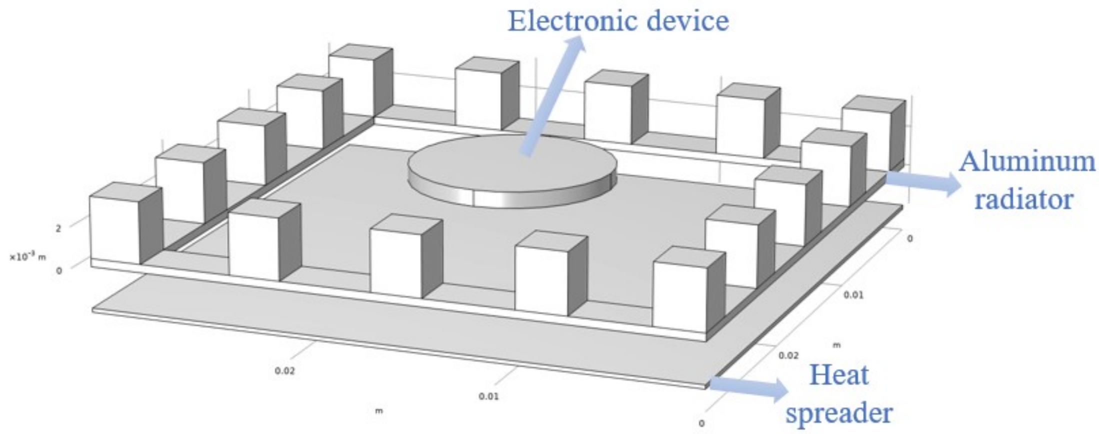

Fig. S9 The assembly of a finite element model about the cooling of electronic device operation.

Supplementary method S1: Finite Element Model

A finite element model, simulating the cooling process during electronic device operation time, was created by the software of COMSOL Multiphysics 5.6. As illustrated in the Fig. S9, this model mainly consists of three parts, referring to electronic device, heat spreader and aluminum radiator. The electronic device continuously generates heat during the operation process. If the heat cannot be dissipated timely, the temperature of electronic device operation rises obviously, which inevitably cause damage to the device quality. 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. Actually, there are still thermal contact resistances occurring between electronic device, heat spreader and aluminum radiator, and these resistances are abstracted as air layer with thickness of 10 μm. Pure nylon, thermal grease and nylon composite paper are used as heat spreader, respectively. Based on the fact that heat mainly transfers along in-plane direction of heat spreader, the in-plane thermal conductivity of materials is critical whereas out-plane thermal conductivity can be ignored. So, when nylon composite paper is chosen as the heat spreader, its thermal conductivity is set as 16.0 W/mK.