

The "two birds with one stone" strategy of flower-like multi-shell hollow microsphere/boron nitride composite achieves dual functionalities of efficient microwave absorption and thermal management

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Characterization

The morphology and surface elemental distribution of the samples were observed using a field emission scanning electron microscope (FESEM, Hitachi Su5000) equipped with an energy dispersive spectrometer (EDS). The microstructure of the samples were observed using transmission electron microscopy (TEM, JEM-F200) and selected area electron diffraction (SAED) for crystalline phase identification. The fourier transform infrared spectroscopy (FTIR, BRUKER INVENIOR), X-ray diffractometer (XRD, Bruker D8 ADVANCE), and raman spectrometer (Raman, Renishaw inVia Reflex) were employed to analyze the phase composition and crystal structure of samples. The chemical valence state information of the samples were obtained through X-ray photoelectron spectroscopy (XPS, Thermo Fisher ESCALAB Qxi). The pore structure of the samples were analyzed using brunauer-emmett-teller (BET, JWGB JWBK200C). The electrical conductivity of samples were measured using a four-probe resistivity tester (FPR, R50-4PP). The magnetic properties of samples were analyzed using a vibrating sample magnetometer (VSM, PPMS-9). The thermal conductivity of the bulk samples was measured using a thermal conductivity meter (TCM, TC 3000E). The surface temperature variation of the bulk specimen was monitored using an infrared photographic thermometry apparatus (IPTA, K20).

Testing of electromagnetic parameters

Add 1.0 g of sample powder to 1.0 g of epoxy resin/hardener premix, with a mass ratio of epoxy resin to hardener of 1:1. After thorough mixing, the mixture is degassed for 15 minutes under a vacuum of not less than 0.1 MPa, then poured into a coaxial ring mold and cured at a constant

temperature of 80°C for 2 hours, ultimately obtaining epoxy resin-based standard coaxial ring specimens with an inner diameter of 3.04 mm and an outer diameter of 7.00 mm.

Testing of thermal conductivity

The sample with 50 wt% was thoroughly mixed with 50 wt% epoxy resin and cured to prepare a bulk specimen measuring $3 \times 3 \times 0.5$ mm for thermal conductivity testing.

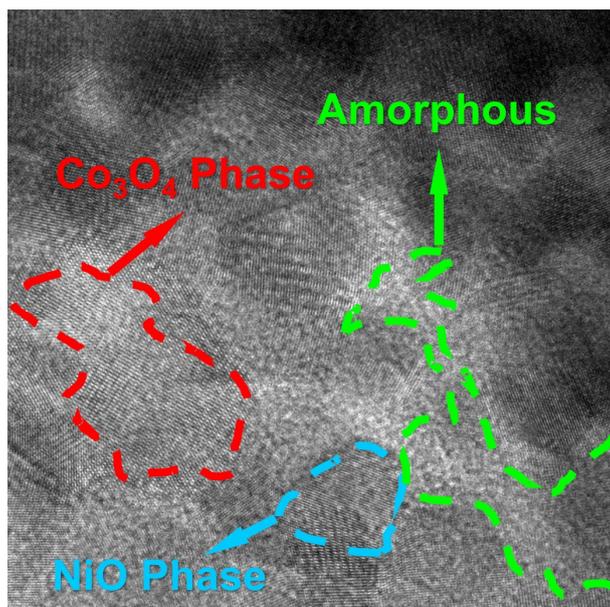


Fig. S1. HRTEM image of FMSHS

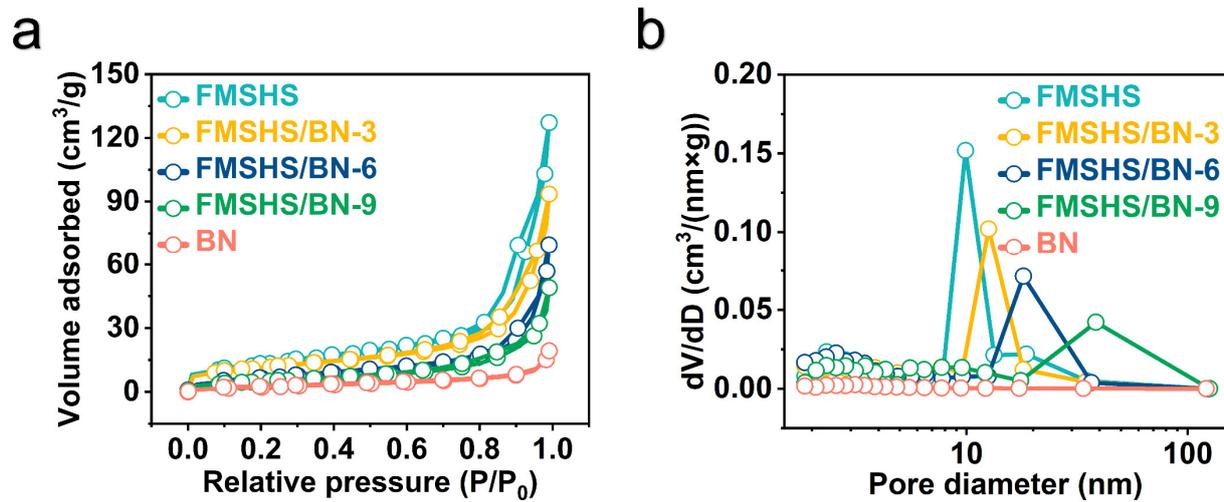


Fig. S2. (a) Nitrogen adsorption-desorption isotherms and (b) diameter distribution curves of FMSHS,

BN, and their composites.

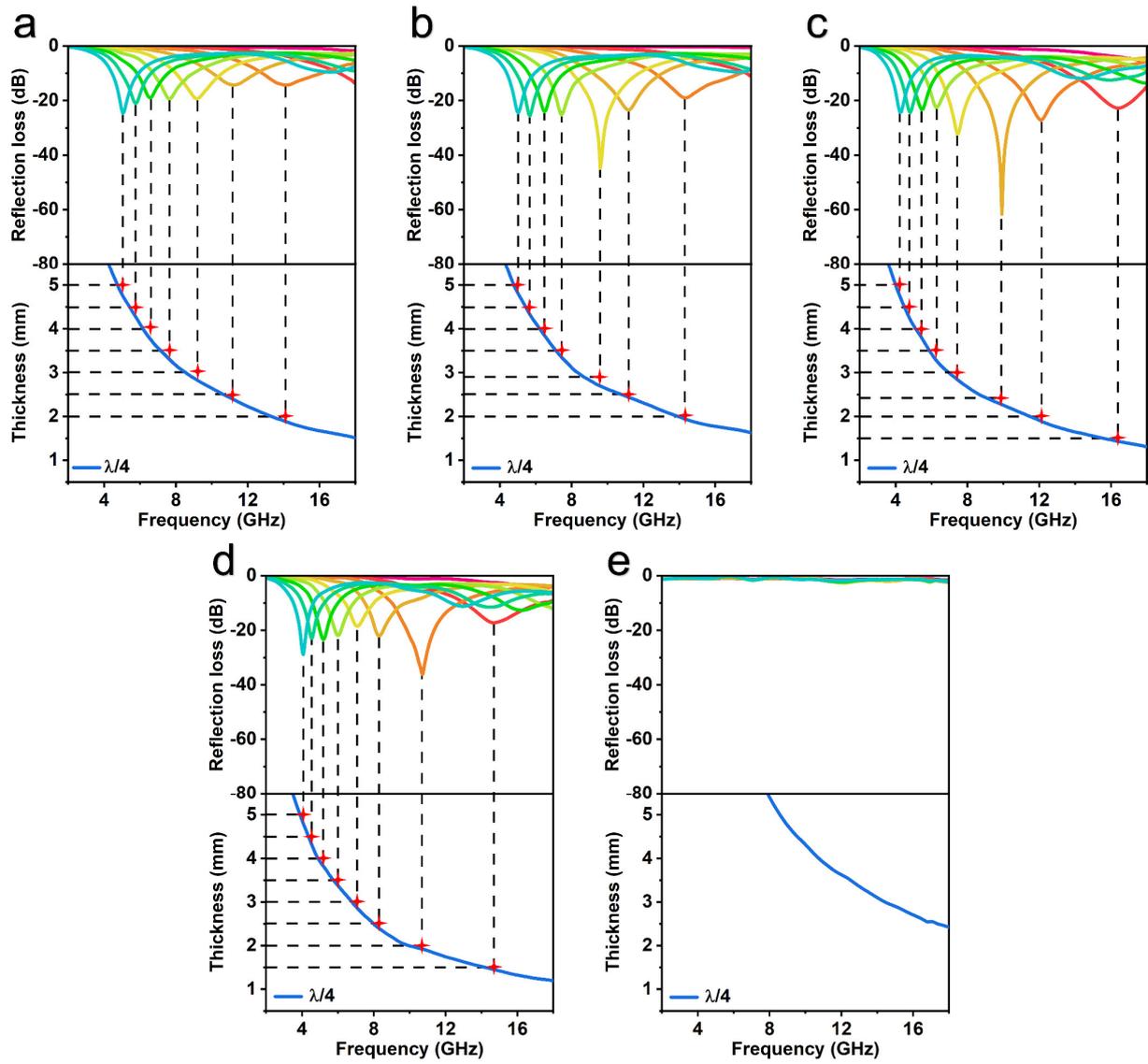


Fig. S3. $\lambda/4$ model of (a) FMSHS, (b) FMSHS/BN-3 composite, (c) FMSHS/BN-6 composite, (d)

FMSHS/BN-9 composite and (e) BN.

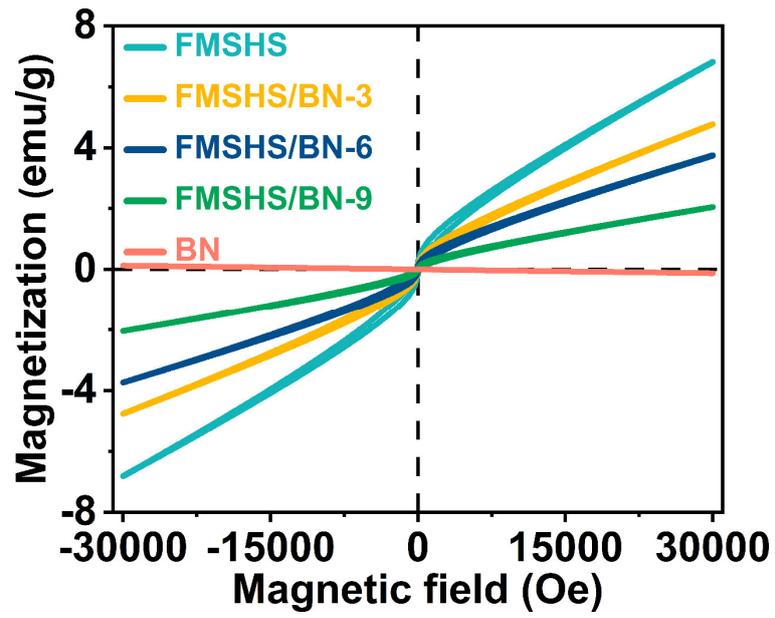


Fig. S4. Magnetic hysteresis loops of FMSHS, BN, and their composites.

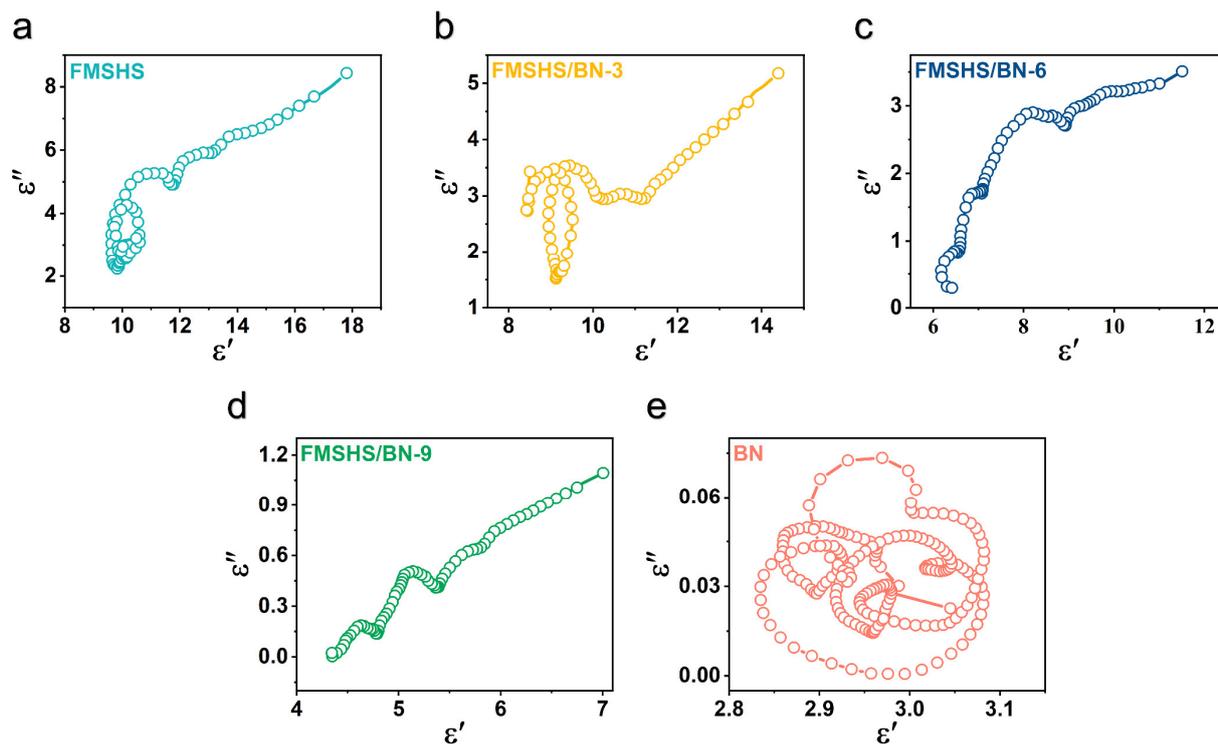


Fig. S5. Cole-Cole curves of (a) FMSHS, (b) FMSHS/BN-3 composite, (c) FMSHS/BN-6 composite, (d) FMSHS/BN-9 composite and (e) BN.

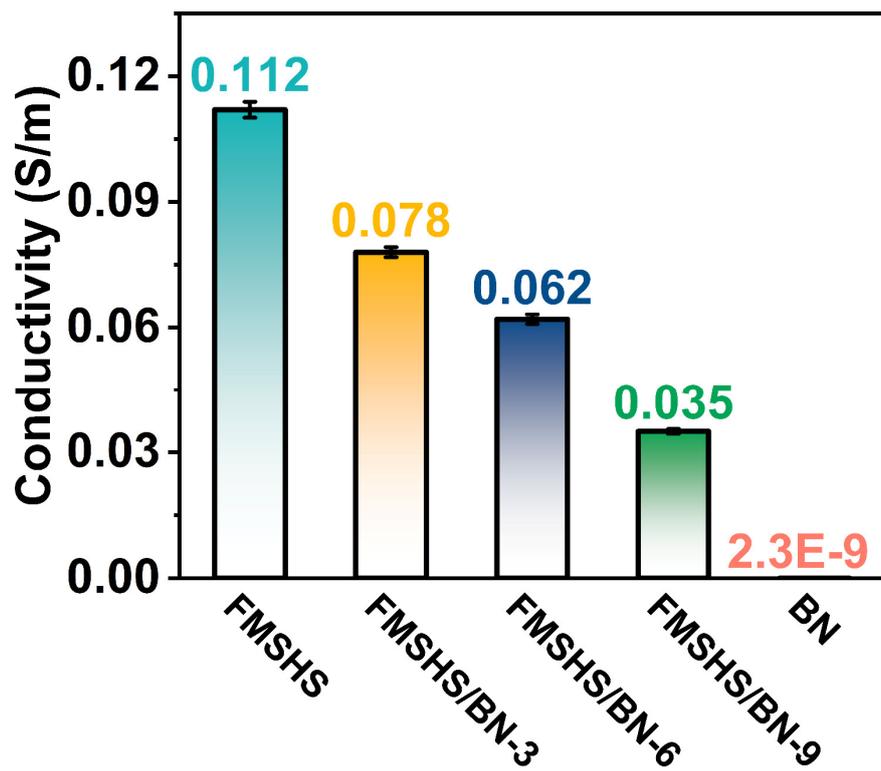


Fig. S6. Conductivity of FMSHS, BN, and their composites.

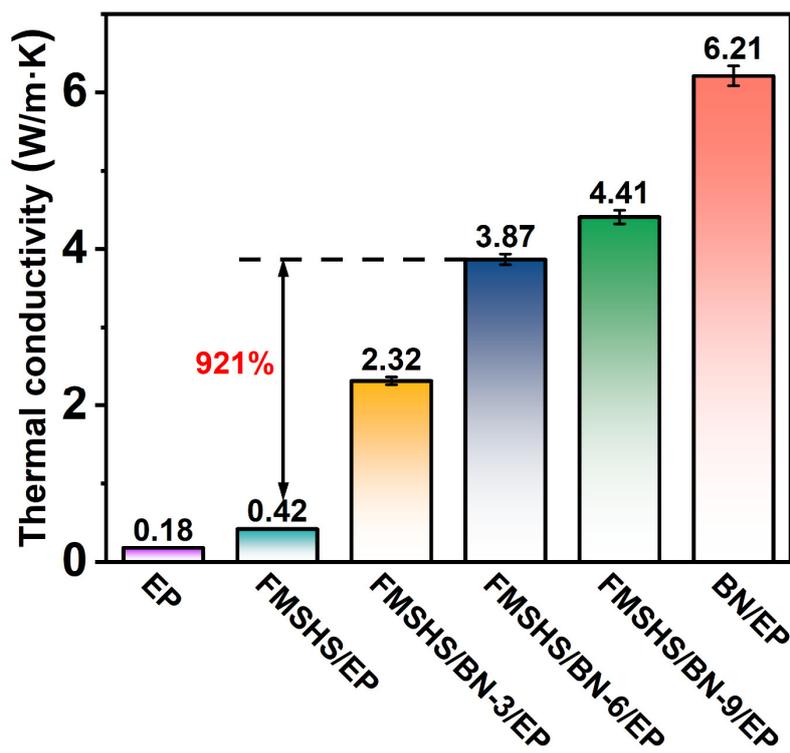


Fig. S7. Thermal conductivity of EP, FMSHS/EP, FMSHS/BN-3/EP, FMSHS/BN-6/EP, FMSHS/BN-9/EP and BN/EP composites.