SUPPORTING INFORMATION

Graphene Foam Embedded Epoxy Composites with Significant Thermal Conductivity Enhancement

Zhiduo liu, ‡[a,b] Yapeng Chen, ‡[a,b] Yifan Li, [c] Wen Dai, [a] Qingwei Yan, [a] Fakhr E. Alam, [a] Shiyu Du, *[c] Zhongwei Wang, [d] Kazuhito Nishimura, [e] Nan Jiang, [a,b] Cheng-Te Lin,*[a,b] Jinhong Yu *[a,b]

[a] *Key Laboratory of Marine Materials and Related Technologies, Zhejiang Key Laboratory of Marine Materials and Protective Technologies, Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences, Ningbo, 315201, China,*

[b] *Center of Materials Science and Optoelectronics Engineering, University of Chinese Academy of Sciences, Beijing 100049, China,*

[c] *Division of Functional Materials and Nanodevices, Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences, Ningbo, Zhejiang, 315201, China,*

[d] *College of Materials Science and Engineering, Shandong University of Science and Technology, Qingdao, 266590, China.*

[e] *Advanced Nano-processing Engineering Lab, Mechanical Engineering, Kogakuin University, Tokyo, 192-0015, Japan.*

Corresponding author, E-mail:* ***dushiyu@nimte.ac.cn; linzhengde@nimte.ac.cn; yujinhong@nimte.ac.cn*

‡ Zhiduo Liu and Yapeng Chen contributed equally to this work.

SUPPLEMENT

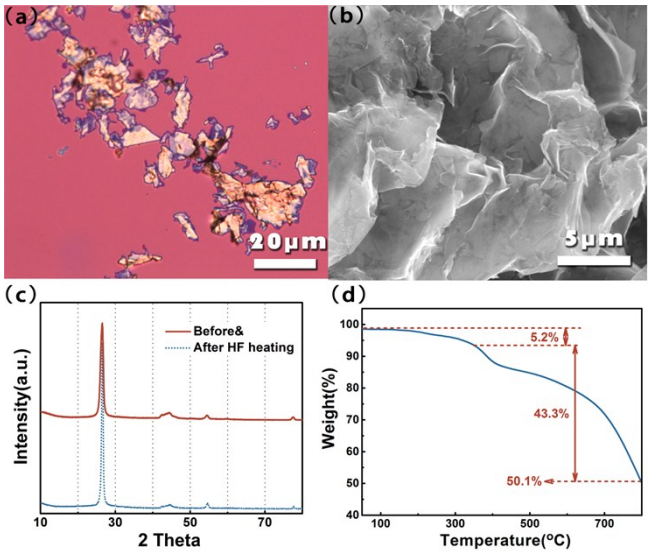

Figure S1 (a) Optical microscope image and (b) SEM of GNPs. (c) XRD patterns of GNPs obtained before and after HF-heating treatment. (d) TGA curve of GNPs powder in N_2.

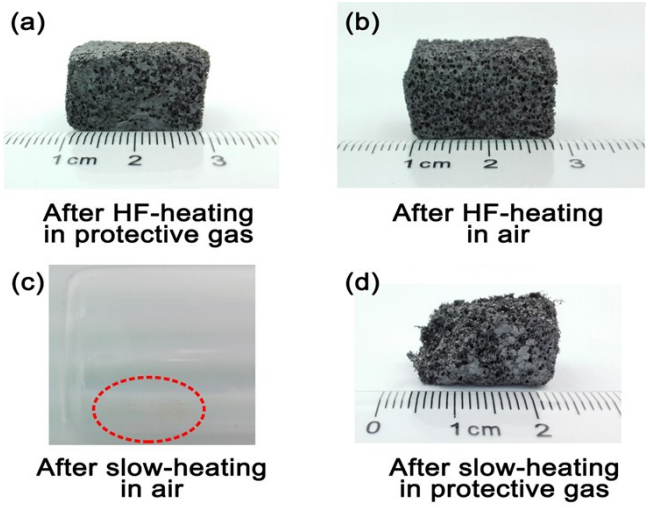

Figure S2 Photograph of graphene foam after (a) HF-heating in protective gas, (b) HF-heating in air, (c) slow heating in air, and (d) slow heating in protective gas.

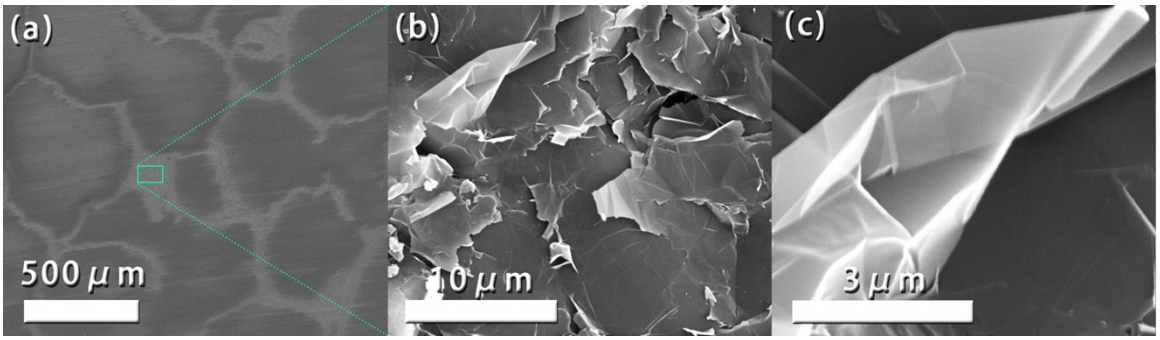

Figure S3 Low- and high-magnification SEM images of GF/epoxy composite.

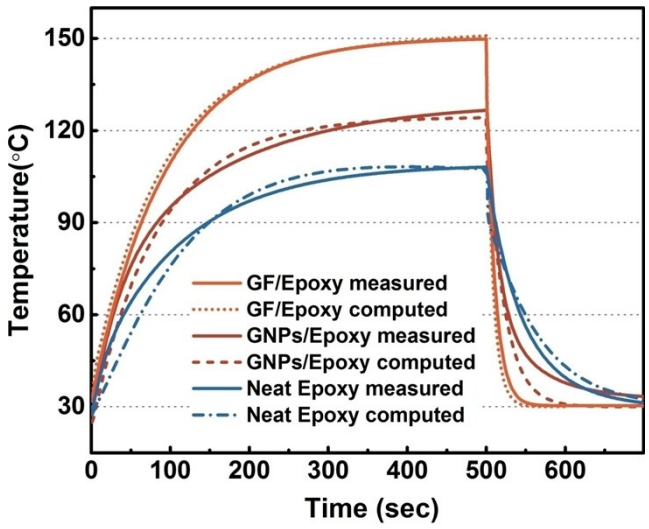

Figure S4 Comparison of experimentally determined temperature-time curve with the computational simulation curve of neat epoxy, GNPs/epoxy, and GF/epoxy composite.

Thermal conductivity measurement

Thermal diffusivity of the GF/epoxy composites with various graphene loading were determined by using the transient laser flash method (LFA 447 Nanoflash NETZSCH), following the test standards of ASTM E-1461 (Standard test method for thermal diffusivity of the solids by the flash method), DIN EN 821 and DIN 30905.

During the test, at a certain set temperature T, a laser beam or a flash xenon lamp emits a pulse of light instantaneously, uniformly irradiating the lower surface of the sample, and the surface layer absorbs the light energy and the temperature rises instantaneously and serves as a hot end. The energy is transmitted to the cold end (upper surface) in one-dimensional heat conduction. The infrared detector is used to continuously measure the corresponding temperature rise process at the center of the upper surface of the sample, and the temperature (detector signal) rise versus time is

obtained. Ideally, the optical pulse width is close to infinity, and the conduction of heat inside the sample is ideal for one-dimensional heat transfer from the lower surface to the upper surface without lateral heat flow. The external measurement environment is ideal for adiabatic conditions. There is heat loss when the upper surface temperature of the sample rises to a constant horizontal line after the apex in the graph. The half-temperature time t_{50} shown in the metering chart is defined as the time required for the (detector signal) to rise to half of the maximum value. Thermal diffusivity α is obtained by the following equation:

$$\alpha = 0.1388d^2/t_{50} \qquad (1)$$

Where d is the thickness of the sample. Thermal conductivity λ (W/mK) can be obtained as a multiplication of thermal diffusivity (α, mm^2/s), specific heat (Cp, J/gK), and density (ρ, g/cm3). Namely,

$$\lambda = \alpha \times Cp \times \rho \qquad (2)$$

Specific heat is measured under nitrogen atmosphere by Pyris Diamond DSC (Perkin-Elmer, USA) with reference method. Density of the samples were determined by liquid displacement method.