Supplementary Information

Thermally reduced graphene oxide films as flexible lateral heat spreaders

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Experimental

The details of the measurement technique and indicate the accuracy of the measurements:

The measurement of thermal diffusivity and specific heat capacity (C_P) refers to the reference[1]

The thermal diffusivity was determined using Laser Flash Apparatus (NETZSCH LFA 447 *NanoFlash*) operated at room temperature in a vacuum of 0.01 Pa. In this method, the test sample was cut into round shape with diameter of 25.4 mm, as the sample carrier is standard with fixed size. Then, the sample was heated at center by light pulse, with the resulting temperature rise at four different positions being

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measured using infrared detector. The thermal diffusivity is determined by analyzing the temperature-versus-time curve based on the following equation:

$$\alpha=0.1388*h^2*t^{-1/2} \quad (1)$$

α is the thermal diffusivity, h is the thickness of the tested sample and t is the diffusion time. Finally, the thermal conductivity (K) was calculated using the Equation (2):

$$K=\alpha*C_P*\rho \quad (2)$$

Herein, ρ is the density of the graphene film, and C_P is the specific heat capacity obtained by differential scanning calorimetry (DSC, NETZSCH DSC 200 F3 Maia). The density (ρ) in Equation (2) is obtained according to ρ = m/V, among which, m and V are the mass and volume of the sample, respectively. The mass was available by weighing the round sample with a diameter of 25.4 mm using electronic precision balance. The volume was determined by the products of flake area and thickness of the sample. The thickness was measured by SEM.

The specific heat capacity (C_P) was measured by DSC. The measurement was conducted using sapphire method according to Equation (3):

$$\frac{DSC_{sample}-DSC_{bas}}{DSC_{standard}-DSC_{bas}}=\frac{C_{Psample}*m_{sample}}{C_{Pstandard}*m_{standard}} \quad (3)$$

DSC_{sample}, DSC_{bas}, $DSC_{standard}$ are the ordinate of the DSC curves corresponding to the sample, blank specimen, and standard specimen, respectively. $C_{P\ sample}$ and $C_{P\ standard}$ are the specific heat of the sample and standard specimen, respectively. m_{sample} and $m_{standard}$ are the mass of the sample and sapphire, respectively.

Three tests including blank test, sapphire test, and sample test were carried out in

turn. Firstly, the base curve of DSC was achieved by the blank test. The sapphire was selected as reference sample with known C_P. Then the DSC curves, heat enthalpy change rate dH/dt as a function of time t, of the sample and sapphire were calibrated with the base curve. Comparing the DSC signal of sample with that of sapphire, c_p of the being tested sample can be calculated based on Equation (3).

The accuracy of K was affected most possibly by the thickness of the film, so the thickness was measured by SEM and the samples used for SEM measurement were obtained from the different location in the film, 10 samples were cut from each film, and the final thickness was the mean value of 10 samples.

Static mechanical uniaxial in-plane tensile tests were performed with dynamic mechanical analyzer (2980 DMA, TA instruments). The films were cut with a razor in rectangular strips of approximately 6mm*15mm. the sample were gripped using film tension clamps with a strain rate of 0.02%/min and preload force of 0.001 N.

Results and discussion

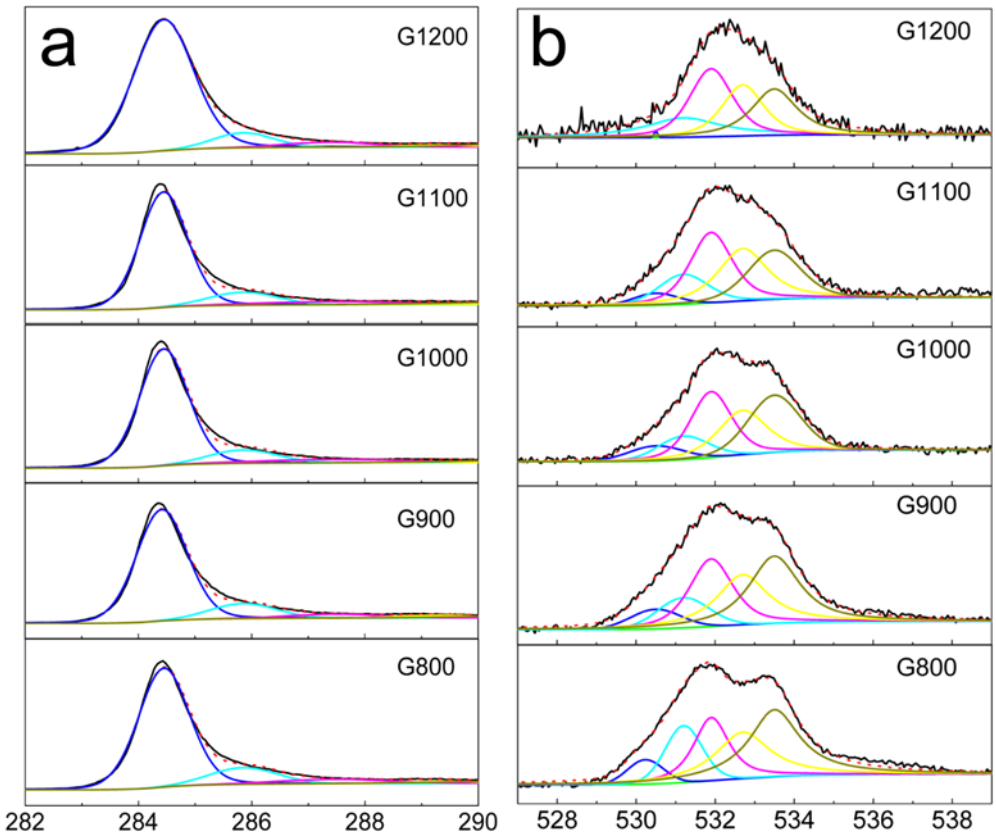

Fig. S1 C1s (a) and O1s (b) fine scan spectrum of film samples

Table S1 Thermal properties of graphene related materials and composites with graphene

Ref.	Material	Thermal Conductivity ($Wm^{-1}K^{-1}$)(300K)	Preparation Method	Measurement Method
[7]	Graphene-Multilayer Graphene Nano-composites	~ 5.1 $Wm^{-1}K^{-1}$at the filler loading fraction f = 10 vol. %.	Graphene-Multilayer Graphene Nano-composites was prepared by adding epoxy resin to the graphene-multilayer graphene suspension followed by heating and degassing	transient "laser flash" technique
[8]	the hybrid graphene - FLG - silver - epoxy composite	~ 9.9 $Wm^{-1}K^{-1}$ at the small 5 vol.% of the graphene-FLG loading	Dispersing the graphene solution in the silver epoxy, and applying the high-shear mixing followed by ultra - sonication	transient planar source technique
[13]	Graphene – Copper - Graphene Films	370 $Wm^{-1}K^{-1}$	Chemical vapor deposition of a single atomic plane of graphene on both sides of 9 μm thick Cu films	"laser flash" method
[14]	GaN devices with graphene quilts	The temperature of the hotspots can be lowered by ~20°C in transistors operating at ~13 Wmm^{-1}	Transfer FLG films on top of AlGaN/GaN devices	micro-Raman spectroscopy with *in situ* monitoring

Reference

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