Electronic Supplementary Information (ESI)

Excellent Heat Dissipation Properties of the Super-Aligned Carbon Nanotube Films

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1. Detailed fabrication process of the SACNT buckypapers

The super-aligned carbon nanotube (SACNT) arrays could be massively produced in our laboratory by the CVD method[1, 2]. Acetylene was used as precursor and the SACNT arrays was grown on silicon wafers at the temperature 650-700 ºC. The growth time is in the range of 5-20 minutes and the height of the SACNT arrays could be controlled from 100-900 μm. The single-layer SACNT films could be directly drawn from the SACNT arrays because of the strong van der Waals forces between individual CNTs[1]. Thousands of layers of the SACNT films were spread together in the same direction and some ethanol was dropped. Then these multilayer SACNT films were pressed by high pressures (~30 MPa). After the evaporation of the ethanol, all the SACNT films were tightly bonded together. In this way, we could get a large-size and compacted SACNT buckypapers.[3, 4] As is shown in the Fig. S1a, individual CNTs in the high-density buckypapers are tightly arranged and individual CNTs are aligned in one direction. The Fig. S1b shows that the buckypapers is flexible and smooth. The thickness of the SACNT buckypapers is about 0.5-0.7 mm. These buckypapers are a kind of anisotropic materials, which have excellent thermal conductivity (~800 W m^{-1} K^{-1}) and mechanical properties in the axial direction.

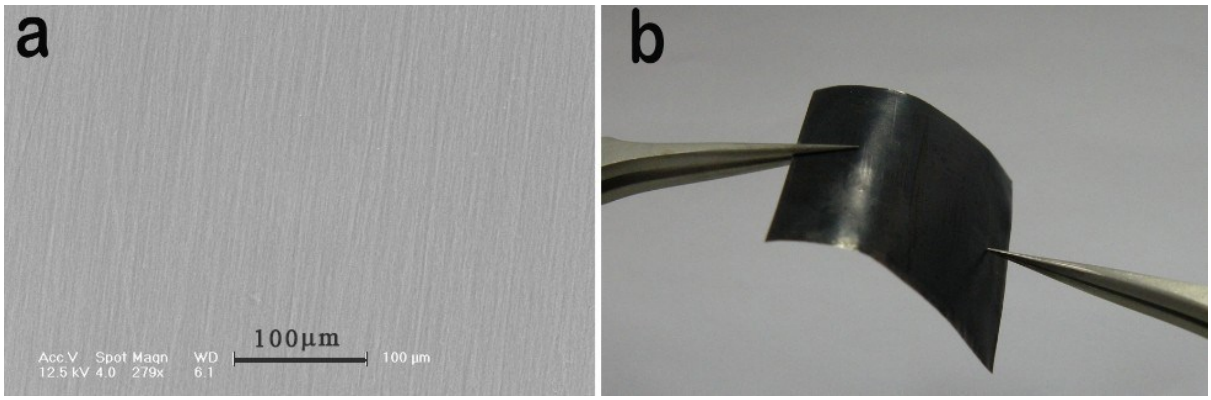

Fig. S1. (a) The scanning electron microscope image of the compacted SACNT buckypapers. (b) The photograph of the compacted SACNT buckypapers.

2. All temperature curves of the eight measured samples

In order to clearly show the results, four typical temperature curves of four corresponding samples were shown in our paper. All the temperature curves of the eight measured samples were shown in the Fig. S2.

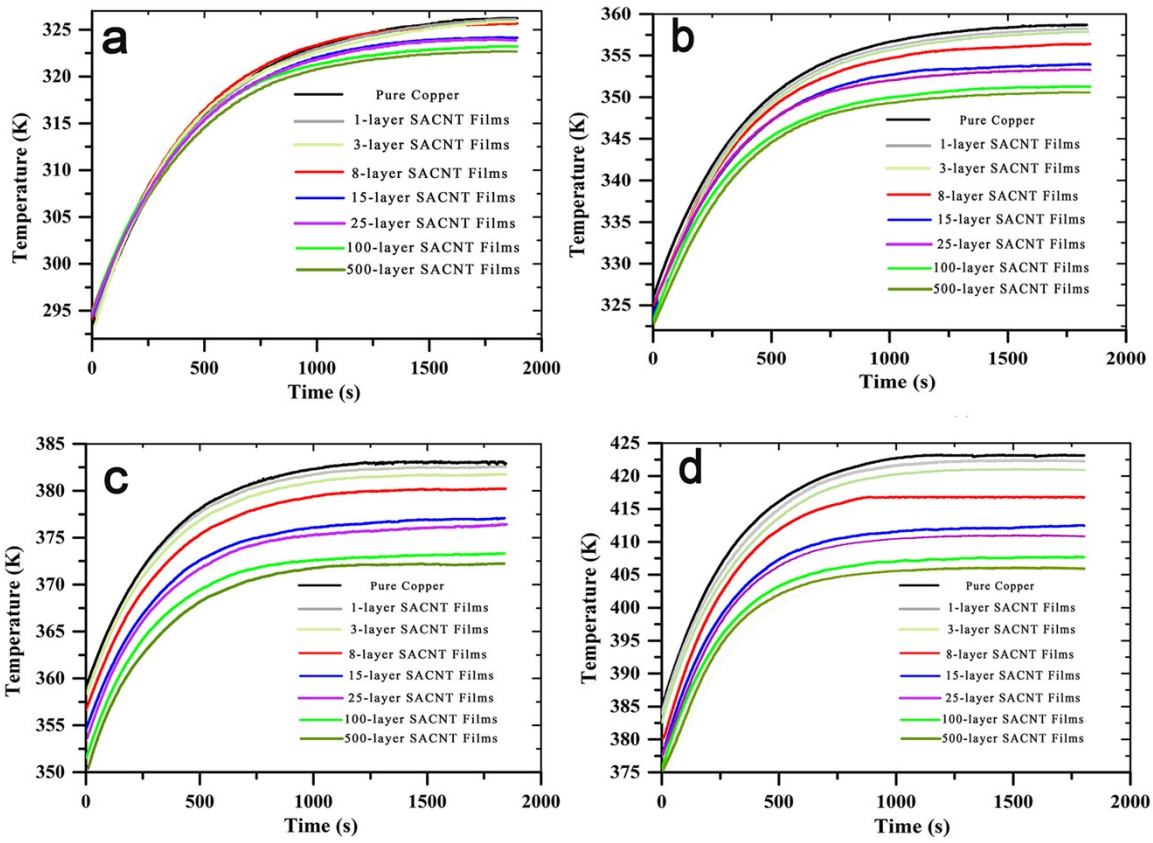

Fig. S2. All temperature curves of the eight measured samples.

3. Detailed preparation process of the CNT CPU-radiator

In order to ensure the practicability of our novel CPU-radiator, we designed the structure of our CNT CPU-radiator according to a traditional CPU-radiator of a laptop. The novel CPU-radiator was prepared by the following steps. Firstly, the large-size buckypapers was cut into a ribbon by a cutting laser. The width of the ribbon is the same with the traditional CPU-radiator. In order to ensure the perfect thermal conductivity of the buckypapers, we cut the buckypaper along arrangement directions of the individual CNTs. Secondly, we folded the buckypaper ribbon at a suitable position, as is shown in the Fig. S3a. In this way, the buckypaper ribbon became an “L-shape” frame, which could maintain the heat conduction along the arrangement direction of individual CNTs. Thirdly, the buckypaper ribbon was folded repeatedly to form the “radiating fins” of the CPU-radiator (shown in the Fig. S3b). In order to fix the shape of the radiator, a metal framework was set to support the “radiating fins”. Then the other sides of the framework were coated by another slice of SACNT buckypapers to achieve good radiative heat dissipation properties (shown in Fig. S3c). The high-purity silver was used to paste the framework and CNT buckypapers. The size of these radiating fins

are the same with the traditional metallic radiator. In this case, the heat from the CPU could conduct along the arrangement direction of individual CNTs. This novel CPU-radiator could be directly pasted on the CPU because it is all-solid-state. The photograph of the CNT CPU-radiator was shown in Fig. S4.

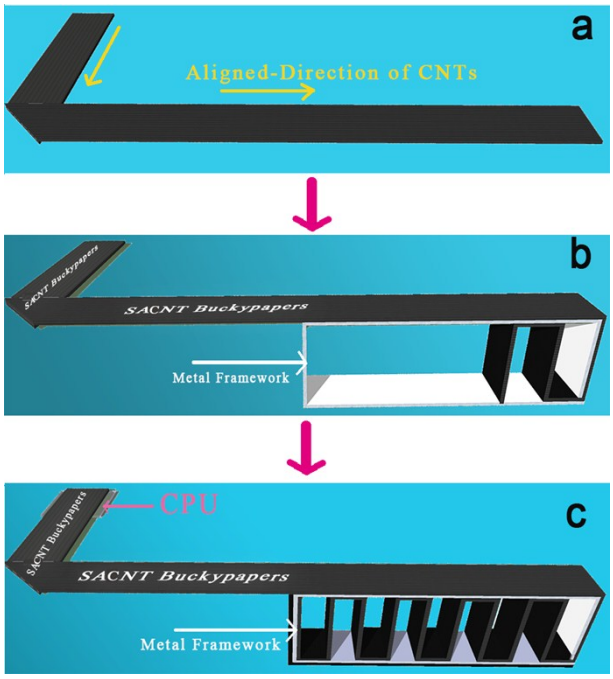

Fig. S3. Detailed preparation processes of the novel CPU-radiator. (a) The SACNT buckypaper ribbon was folded at a suitable position. (b) The SACNT buckypaper ribbon was repeatedly folded to form radiating-fins of the CPU-radiator. (c) The other sides of the metal framework were covered by another slice of SACNT buckypapers to achieve good radiative heat dissipation properties.

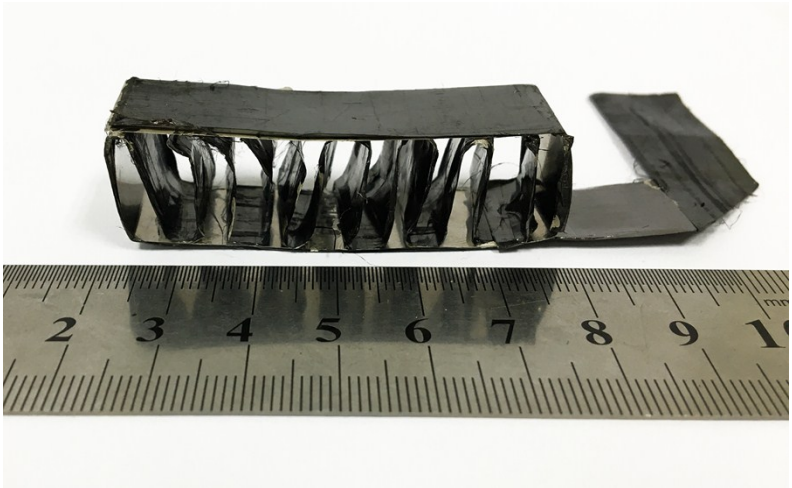

Fig. S4. The photograph of the as-prepared CNT CPU-radiator.

4. Heat dissipation property comparison of the two CPU-radiators

Heat dissipation properties of the two CPU-radiators were tested and compared by the following method. The software "Core Temp"[5] was applied to monitor the temperatures of the CPU when the laptop running the stress-testing software "LDSBenchmark".[6] The temperature curves are shown in the Fig. S5. When the stress testing software was started, the CPU temperatures increased rapidly. Because of the working of the radiator-fans, the working temperatures of the CPU equipped with the CNT-radiator vibrate around 65-67°C. Conversely, the working temperatures of the CPU equipped with the metal-radiator could reach above 72 °C. Then the working temperature decrease rapidly because of the working of the radiator-fans and the self-protections of the CPU. The comparison of the two temperature curves in the Fig. S5 confirm that the CNT-radiator have better heat dissipation than the metal-radiator. Furthermore, the CNT-radiator could make the laptop stable working and power saving.

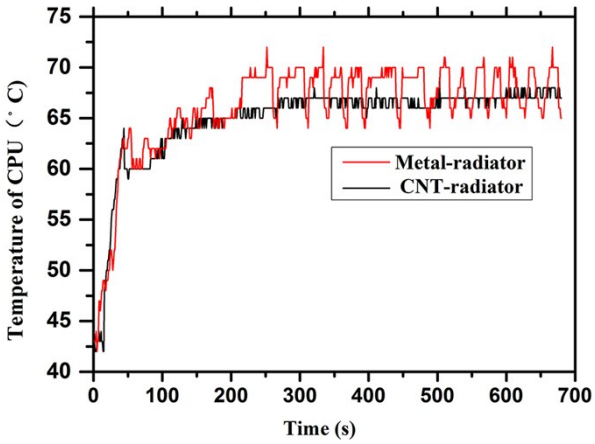

Fig. S5. The working-temperature curves of the CPU when it is respectively equipped with the two radiators.

References:

1. K. Jiang, J. Wang, Q. Li, L. Liu, C. Liu and S. Fan, *Adv. Mater.*, 2011, **23**, 1154-1161.
2. K. L. Jiang, Q. Q. Li and S. S. Fan, *Nature*, 2002, **419**, 801.
3. L. Zhang, G. Zhang, C. Liu and S. Fan, *Nano Lett.*, 2012, **12**, 4848-4852.
4. G. Zhang, C. Liu and S. Fan, *ACS Nano*, 2012, **6**, 3057-3062.
5. http://www.alcpu.com/CoreTemp/.
6. http://www.ludashi.com/.