

## Supporting Information

### **A gigantically increased ratio of electrical to thermal conductivity and synergistically enhanced thermoelectric properties in interface-controlled TiO<sub>2</sub>-RGO nanocomposites**

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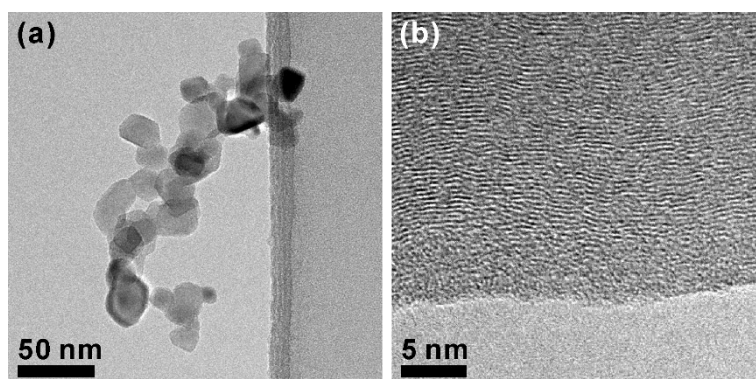
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1. TEM images of the TiO<sub>2</sub> nanoparticles (P25) and the GO

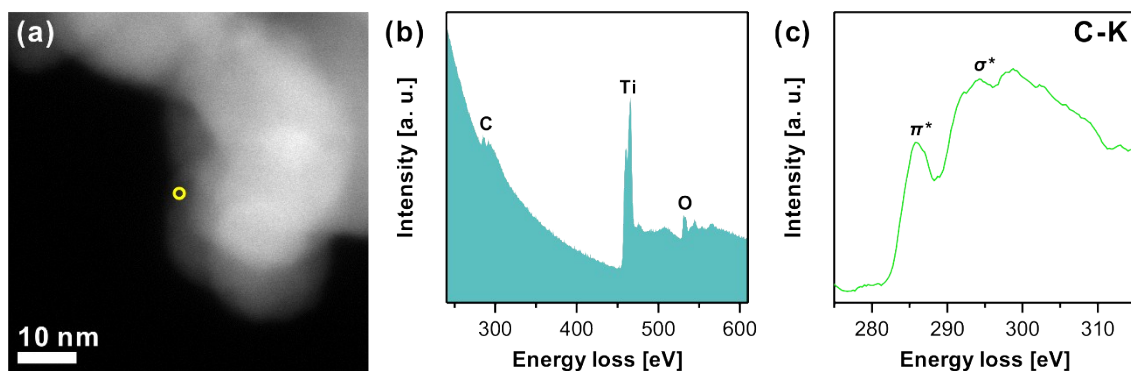


**Fig. S1.** Bright-field TEM micrographs of (a) the TiO<sub>2</sub> nanoparticle (P25) and (b) the GO.

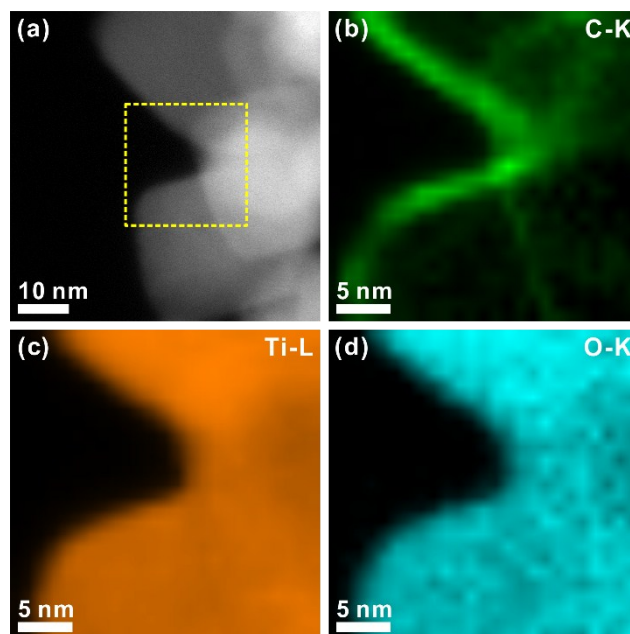
## 2. STEM-EELS characterization of the TiO<sub>2</sub>-RGO hybrid powder

We tried to confirm the presence of the RGO in the TiO<sub>2</sub>-RGO hybrid powder using a scanning TEM-electron energy-loss spectroscopy (STEM-EELS, Titan G2, FEI) technique. Fig. S2b shows an EELS spectrum that was taken from the outer area of the hybrid powder (yellow circle region in high-angle annular dark-field (HAADF)-STEM micrograph (Fig. S2a)). It shows the C-K, Ti-L, and O-K edges at 285, 465, and 532 eV, respectively. Two distinct peaks related to  $1s - \pi^*$  and  $1s - \sigma^*$  transitions can be observed in magnified view of the C-K edge (Fig. S2c), and it reveals  $sp^2$  hybridization of carbon atoms in RGO layer.<sup>1-3</sup>

Furthermore, the elemental distribution of the hybrid powder was examined using a STEM-EELS mapping. Fig. S3a is a HAADF-STEM micrograph, and Figs. S3b-d show the corresponding carbon, titanium, and oxygen elemental maps from the yellow-dotted region in Fig. S3a, respectively. As shown in this figure, carbon element (RGO) was well coated on the surface of the TiO<sub>2</sub> nanoparticles.



**Fig. S2.** (a) A HAADF-STEM micrograph of the TiO<sub>2</sub>-RGO hybrid powder. (b) An EELS spectrum acquired from the yellow circle area in (a). (c) A magnified view of the C-K edge.



**Fig. S3.** (a) A HAADF-STEM image of the  $\text{TiO}_2$ -RGO hybrid powder and the EELS elemental maps of (b) carbon, (c) titanium, and (d) oxygen from the yellow-dotted region in (a).

### Supporting information references

- 1 A. Dato, V. Radmilovic, Z. Lee, J. Phillips and M. Frenklach, *Nano Lett.*, 2008, **8**, 2012-2016.
- 2 S. Wakeland, R. Martinez, J. K. Grey and C. C. Luhrs, *Carbon*, 2010, **48**, 3463-3470.
- 3 R. Kumar, R. K. Singh, P. Kumar Dubey, D. P. Singh, R. M. Yadav and R. S. Tiwari, *RSC Adv.*, 2015, **5**, 7112-7120.