Supporting Information

Electron and phonon transport in Au nanoparticle decorated graphene nanoplatelet nanostructured paper

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TGA (decomposition of PEI)

TGA curve of the neat polyethyleneimine decomposed in air is shown in Figure S1. It is noted that PEI begins major decomposition at around 300˚C. In addition, the TGA curves of the as-made GNP paper, annealed GNP paper and as-made Au/GNP hybrid prepared at 0.6wt% PEI are shown in Figure S2. PEI decomposition can be observed in both the as-made GNP and Au/GNP hybrid samples. While for the annealed GNP sample, major decomposition event occurs at the oxidation temperature of GNP itself, indicating that PEI is removed from the sample.

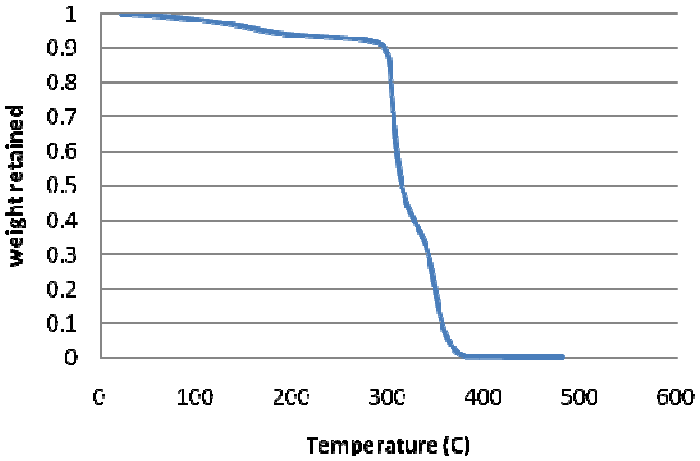

Figure S1: TGA curve of neat PEI in air

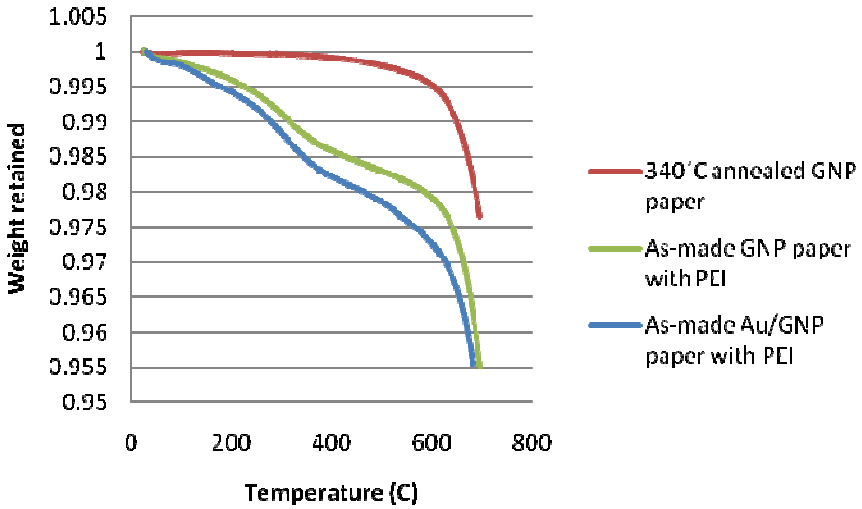

Figure S2: TGA curves of annealed GNP paper, as-made GNP paper and as-made Au/GNP paper in air.

Size distribution of Au nanoparticles on GNP by Image-Pro

The size distribution data shown in Fig.2 was obtained by analyzing the SEM images in Image-Pro, which is a software commercially available. The general procedures are described below: select a SEM image with a magnification of at least 80k, adjust the contrast until the Au nanoparticles stand out from the background. Let the software pick out the Au nanoparticles according to the pre-determined selection criterions (e.g. diameter ≥ 4nm, 1≤aspect ratio≤1.5). The average diameter of each nanoparticle on the analyzed SEM is shown and the histogram is plotted according to this information. Figure S3 is a representative SEM that was analyzed by the software. Figure S4 is the statistics of the nanoparticle distribution.

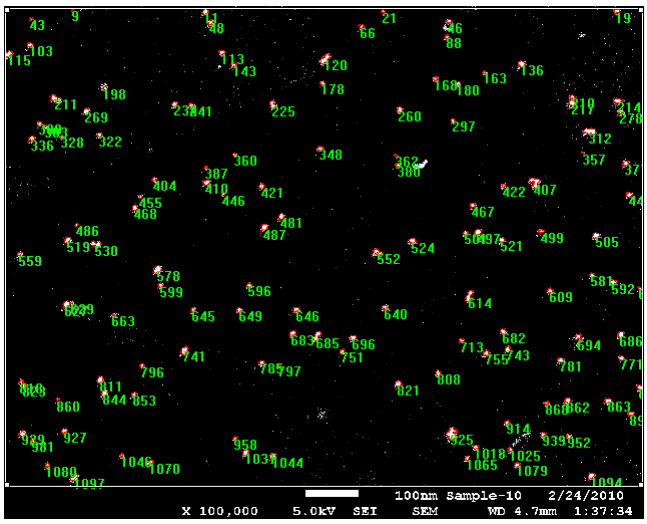

Figure S3: Example SEM images analyzed by Image-Pro to determine the distribution of nanoparticle size (×100k)

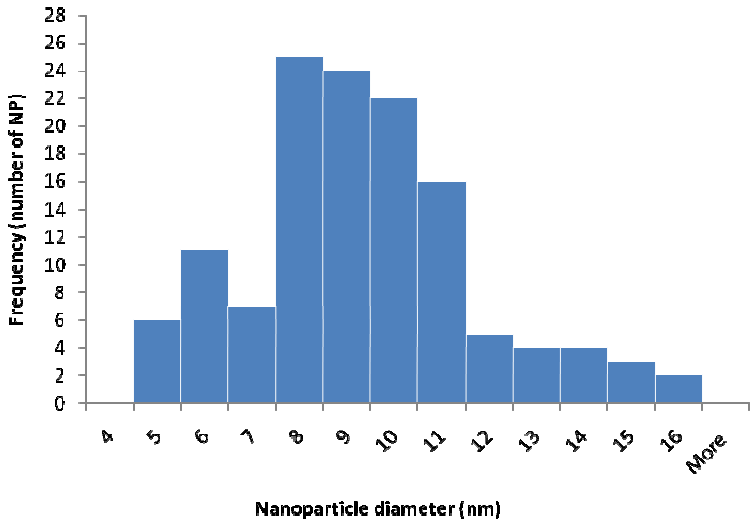

Figure S4: Particle size distribution obtained from Figure S3.

Two point through-plane electrical resistivity measurements of thin film (<100μm)

The reported through-plane electrical resistivity is measured by the two point probe method because of the inherent geometric constraints of working with a thin film. However, the configuration is different from the in-plane four point probe measurement where a tip probe is in contact with the sample, giving rise to a very large contact resistance. In order to eliminate the effect of contact resistance, strips of adhesive copper foils were used to cover the top and bottom surfaces of the sample to spread the electrical current. Figure S5 shows cross sectional schematics of the measurement:

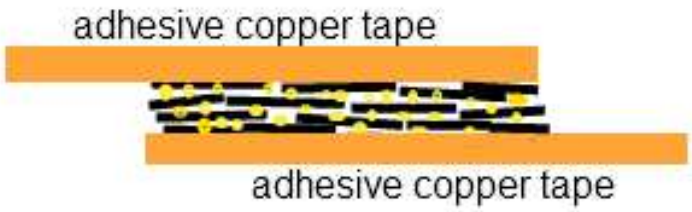

Figure S5: Scheme of through-plane resistivity measurement of thin film sample

It is noted that the resistance measured include the resistances of the copper tapes, the contact and the resistance of the sample. To account for the effect of copper and the contact, a gold foil with similar geometry to the samples (100μm in thickness, 99.99%, Sigma Aldrich) was used to estimate copper and contact resistance because the resistance of the gold foil in this case is negligibly small. The measured resistance is 0.26 ohm which is around 10% of the measured sample resistance. Therefore, the data reported is modified by subtracting 0.26 ohm from the measured sample resistance to obtain the electrical resistivity.