Self-assembled magnetic nanoparticles of Prussian blue on graphene

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Supporting Information

1. Determination of Magnetic ordering temperature (T_C) of PB deposited on Graphene:

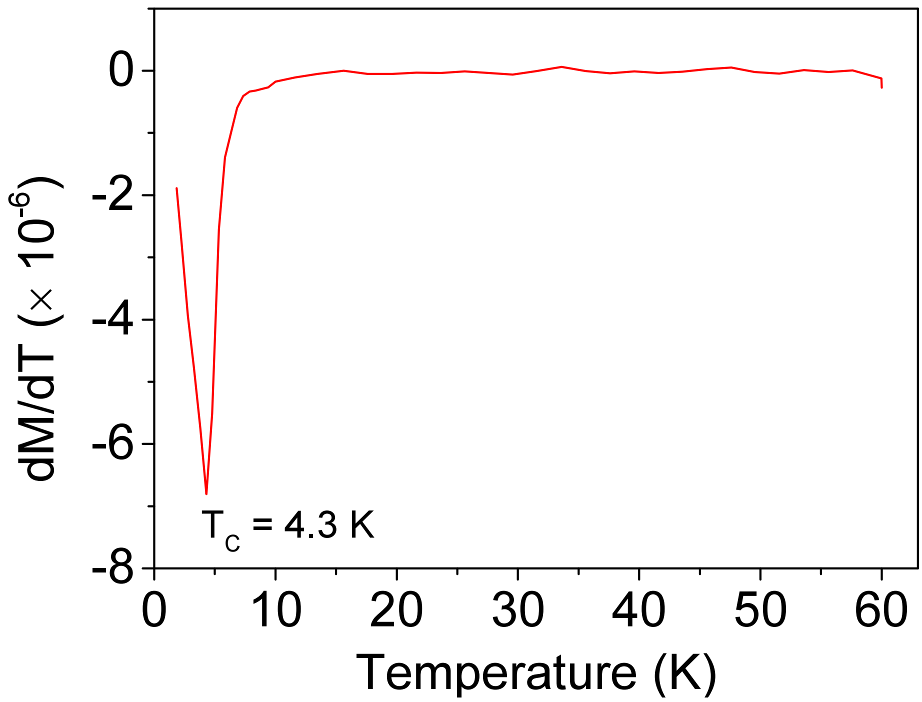

Fig. S1: d*M*/d*T* vs. *T* curve of the graphene on Si substrate coated with 10 cycles of Prussian blue (PB) deposition.

In the presence of large diamagnetic (negative) contribution from the Si substrate and graphene, the T_C can be determined from the derivative of the magnetization (d*M*/d*T*) curve.[1-3] In this case, the constant diamagnetic contribution will vanish in (d*M*/d*T*) vs. *T* curve. Therefore, the T_C of PB (on the Si substrate with graphene flakes) have been determined from the minimum of d*M*/d*T* vs. *T* curve. The magnetic ordering temperature (T_C) is defined as a point of maximum rate of change of magnetization (*M*) with temperature (*T*) i.e. temperature corresponding to the minimum value of the d*M*/d*T*. This method gives a T_C of 4.3 K for PB nanoparticles of ~ 30 nm size.

2. Fabrication of Graphene Hall bar devices and electrical measurements:

The mono/bilayer graphene sheets were obtained by mechanical exfoliation of highly oriented pyrolytic graphite (HOPG) onto Si substrates coated with 300 nm thick layer of SiO_2. The dual layer (200k/140 nm: 950k/60 nm) polymethyl methacrylate (PMMA) resist was spin-coated on top of these graphene sheets and baked at 160 ^{0}C for 4 minutes on a hot plate. Pre-patterned contacts were written on these graphene sheets using e-beam lithography. The e-beam lithography patterns were developed in 1:3 Methyl isobutyl ketone (MIBK) : isopropyl alcohol (IPA) mixture for 1.5 min, and then immersed for 1 min in the stopper (IPA). The developed substrates were deposited with 3 nm of Ti (as a sticky layer) and 30 nm of Au metal in a metal evaporator. The lift-off for removal of unwanted metal was carried out by immerging the metal deposited substrates in N-Methyl-2-pyrrolidone (NMP) at 60 ^{0}C for 2 – 4 hours. The fabricated devices were annealed in Ar gas at 120 ^{0}C for 12 – 24 hours.

For transport measurements, an alternating current (1kHz) of 10 nA was applied across contacts 1 & 2 and longitudinal and Hall resistances were calculated by measuring voltage drop across contacts 3 & 4 and 3 & 5 [Fig. 3 (a) in the main article], respectively, using a lock-in amplifier.

References

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