Record-Breaking Magnetoresistance measured in Natural Graphite

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Funding Grants: G.S. Boebinger (NSF DMR-1157490, NSF DMR-1644779); M.J. & N.K.C. (U.S. DOE, BES *"Science at 100T"*); C.E.P., J.B-Q., P.D.E (DAAD 57207627, DFG ES 86/29-1 & 31047526)

The transport properties of ordered graphite samples are currently of interest because there is expected to be localized superconductivity and/or magnetic order due to the existence of "flat bands" localized at certain 2D interfaces normal to the c-axis. High-quality interfaces of large area are found between crystalline regions that have different stacking orders and/or different twist angles, labelled "interfaces" in (a).

In order to contact directly the embedded interfaces, MagLab users placed several electrodes at the edge (see (b)). The temperature dependence of the resistance (see (c)) shows a record-low value of R(4.8K)/R(390K) at the smallest electrode distance (d_s). *The magnetoresistance (MR), the change of the resistance with magnetic field applied normal to the interfaces (see (d)) achieves record high values of ~100,000 at 0.48K and 21T and exhibits a giant magnetic anisotropy.*

This MR of certain graphite interfaces exceeds in some temperature and field region the largest reported in any other solid. *The results support the notion that granular superconductivity is embedded at certain interfaces.* To obtain the properties of these interfaces at T>100K, one further needs to minimize the parallel contribution of the semiconducting multigraphene matrix around the interfaces, which is the main origin of the field dependence observed at T>100K in (d).

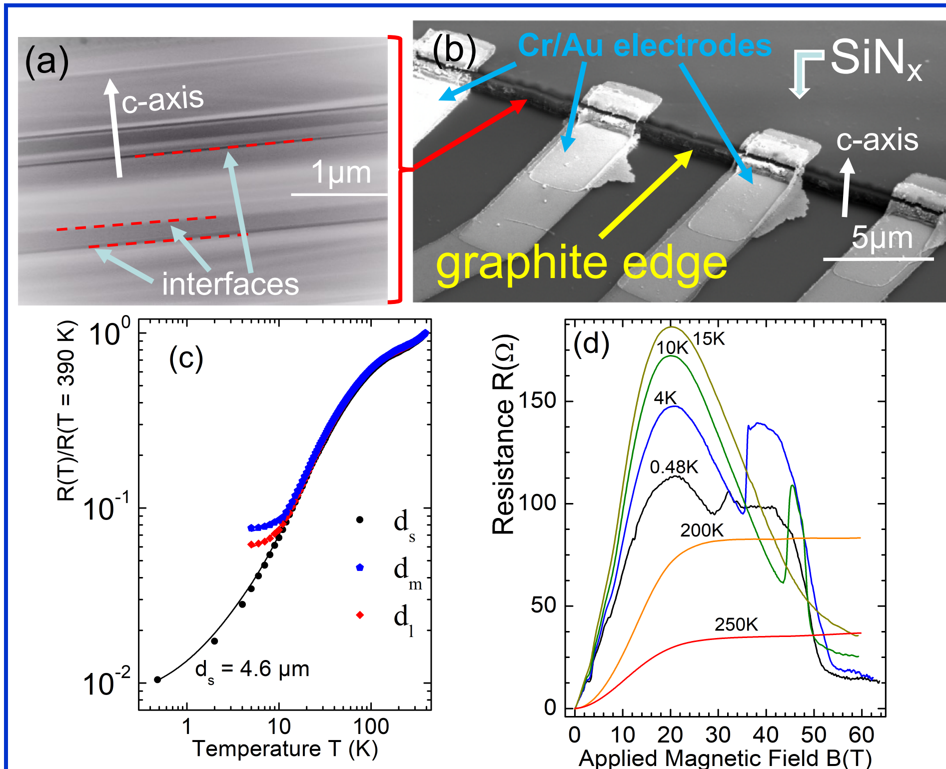

Figure: (a) Scanning transmission electron microscopy image showing the internal structure of the sample with its interfaces. **(b)** Scanning electron microscopy image of part of the sample with Cr/Au electrodes on its edge. **(c)** Temperature dependence of the normalized resistance of the sample at different voltage–electrodes distances localized at the same sample edge, as shown in panel (b). **(d)** Field dependence of the resistance at different temperatures for the shortest electrode distance, labelled "d_s" in panel (c).

Facilities and instrumentation used: NHMFL PFF & LANL, 65T short pulse magnet

Citation: Precker, C.E.; Barzola-Quiquia, J.; Esquinazi, P.D.; Stiller, M.; Chan, M.; Jaime, M.; Zhang, Z.; Grundmann, M., *"Record-Breaking Magnetoresistance at the Edge of a Microflake of Natural Graphite"*, **Advanced Engineering Materials 21** (12), 1900991 (2019) doi.org/10.1002/adem.201900991