High-mobility graphene from chemical vapor deposition on reusable copper

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Over the past years many promising applications of graphene have been demonstrated on individual devices. In order to advance from basic research towards scalable industrial applications, large area high quality graphene is needed. One promising approach to achieve this is chemical vapor deposition (CVD) of graphene on copper. However, so far the charge carrier mobility of CVD grown graphene has been significantly lower than what has been observed in devices fabricated from exfoliated graphene. We will show that the electronic quality of CVD graphene depends critically on the transfer method and we present a dry transfer technique for CVD-grown graphene crystals (see Figure 1) that yields devices encapsulated in hexagonal boron nitride (hBN) with carrier mobilities up to 350,000 cm^2/Vs [1]. In addition to the diffusive transport in such samples, we demonstrate an elastic mean free path exceeding one micrometer at temperatures of up to 200 K using Hall cross devices. By investigating large samples we furthermore conclude that the mean free path can exceed 25 micrometer at 2 K [2]. Thus, in summary we show that the electronic properties of CVD-grown "synthetic" graphene can in principle match those of ultrahigh-mobility exfoliated "natural" graphene.

References

[1] L. Banszerus, M. Schmitz, S. Engels, J. Dauber, M. Oellers, F. Haupt, K. Watanabe, T. Taniguchi, B. Beschoten and C. Stampfer, Science Advances **1**, e1500222 (2015).
[2] L. Banszerus, M. Schmitz, S. Engels, M. Goldsche, K. Watanabe, T. Taniguchi, B. Beschoten and C. Stampfer, Nano Letters **16**, 1387 (2016).

Figure

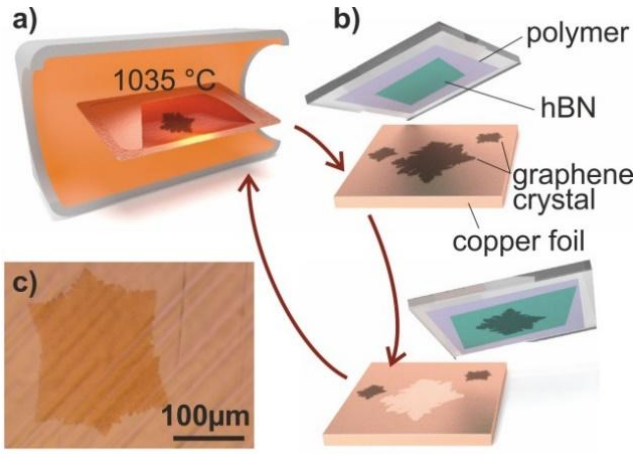

Figure 1: a) Graphene crystals grow on the inside of a copper enclosure. b) Schematic of the transfer process. The graphene is lifted of the copper foil using the van-der-Waals interaction with an hBN flake on a polymer stamp and can be placed on arbitrary substrates avoiding wet chemical contaminations. c) Optical image of a graphene flake on copper.