Grain coalescence and electronic properties of epitaxial graphene

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Epitaxial growth of graphene on SiC is a candidate system for the growth of graphene on a scale large enough for technological applications [1]. Growth is achieved by annealing at temperatures above 1200C, causing Si to evaporate from the SiC preferentially to C, with the resulting carbon-rich surface forms a graphitic layer, with the structural and electronic properties extremely sensitive to annealing conditions. Crucially, in this system both the supply of carbon and the conditions under which the graphene films coalesce are temperature dependent and therefore closely coupled [2].

We present data from magnetotransport and low energy electron microscopy (LEEM)measurements for (0001) 4H SiC samples annealed under UHV at various temperatures, showing structural and electronic coherence lengths which are in good agreement. The evolution of coherent electronic transport occurs for samples annealed at higher temperatures as the size of individual graphene domains increases from the tens of nm to micron scale under these conditions (shown in figure 1). Using a lower-temperature anneal followed by an additional higher-temperature treatment, we show that the larger grain size is due to a coalescence mechanism, as opposed to faster propagation of single grains. This suggests a means of partially decoupling the carbon supply from the coalescence process: potentially important for integration with large-scale wafer production.

Following lithographic patterning, magnetotransport (MR) data have been taken at various cryogenic temperatures and can be fitted to weak localisation (WL) or weak anti-localisation (WAL) models [3, 4], allowing the various electron scattering rates to be ascertained. Following these fitting procedures, subtraction of the fits from the measured data allows less dominant contributions to magnetotransport to be discerned. For less ordered samples, it is necessary to include an electron-electron interaction term to fit successfully to low-temperature MR data, while the temperatures at which this becomes necessary agree with a deviation from linear temperature dependence of the scattering rate τ_φ.

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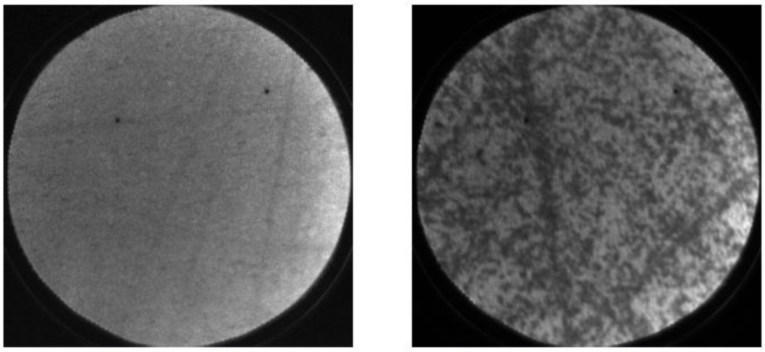
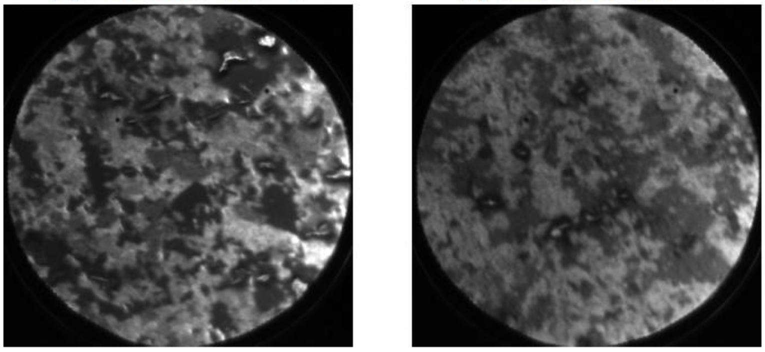
Figure 1



(a) 20 minutes 1300 °C

(b) 60 minutes 1300 °C



(c) 30 minutes 1400 °C

(d) 55 minutes 1400 °C

LEEM images of samples annealed under UHV with varying conditions. Field of view in each case is 10 μm.