Oxygen assisted monocrystalline graphene growth by chemical vapor deposition

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Monocrystalline single layer graphene is an appealing material for applied research due to its exceptionally large carrier mobility - a key parameter for most applications in electronics - and strong THz optical response, for photonic applications**.** However, for an industrial scale exploitation of these properties, it is necessary to obtain high quality graphene by scalable means, e.g., by chemical vapour deposition (CVD) [1]. For single layer graphene growth it is preferable to use copper instead of, for example, nickel substrates due to the low carbon solubility in copper [2]. The number and size of the graphene crystal grains is, in a first approximation, determined by the copper substrate characteristics. Therefore, it is necessary to treat the high-purity copper for control of its cleanliness, oxidation state, and roughness. . Substrates were treated in an ultrasonic bath with an acidic solution of HCl and $FeCl_3$, followed by oxidation in air (hot plate) at 180ºC for 30 minutes. Keeping an extended oxidized surface is key to obtain very low nucleation density, providing graphene crystals of large size and good quality. For graphene growth, the copper substrates were enclosed in a graphite confinement box to increase growth rate [3] while protecting the sample from silicon oxide and other contaminations coming from reactions with the quartz walls of the reactor. A secondary height-controlled sapphire cavity is used to accommodate the substrate inside the primary graphite cavity and release in situ trace amounts of oxygen that keep the Cu substrate oxidation level, and further increase growth rate and reduce nucleation density. The consistency in this step is fundamental to achieve a good reproducibility of the results. Samples are characterized by microscope inspection for flake size and morphology, after which they are transferred onto Si/SiO_2 substrates, using the wet polymer transfer process, for Raman spectroscopy analysis.

REFERENCES

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FIGURES

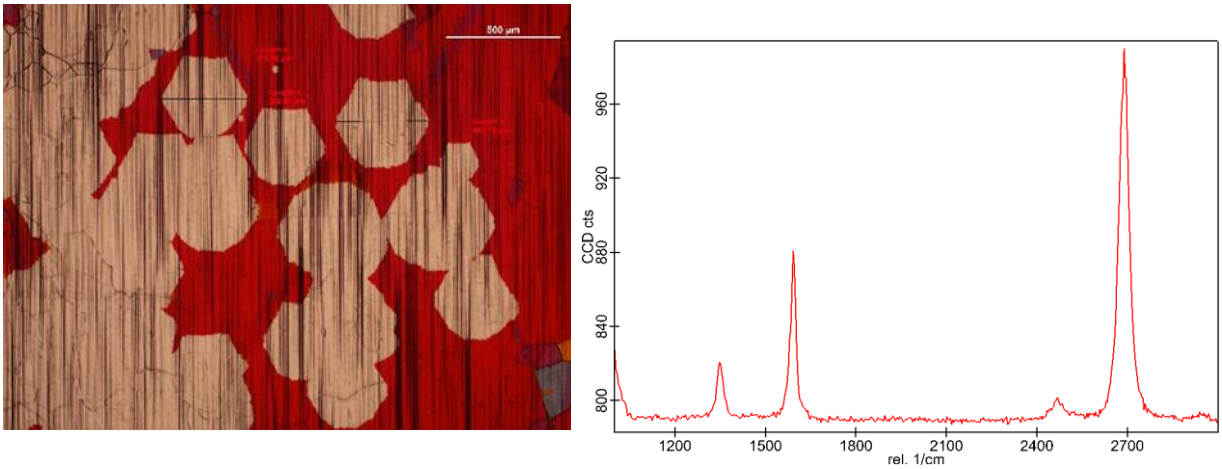

Figure 1: Hexagonal graphene flakes (left) with 400 µm diameter and Raman spectrum of transferred graphene (right).