Graphene growth on h-BN by molecular beam epitaxy

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Graphene growth on dielectric substrates has potential to enable new kinds of devices and applications. We explore graphene growth via direct depositing carbon in a MBE environment on different dielectric substrates, such as h-BN and sapphire.
The growth of single layer graphene nanometer size domains by solid carbon source molecular beam epitaxy on hexagonal boron nitride (h-BN) flakes is demonstrated [1]. Formation of single-layer graphene is clearly apparent in Raman spectra which display sharp optical phonon bands (see Fig. 1 (a)). Atomic-force microscope images and Raman maps (Fig. 2) reveal that the graphene grown depends on the surface morphology of the h-BN substrates. On h-BN substrates, high quality single layer growth occurs as nano-domains. The growth is governed by the high mobility of the carbon atoms on the h-BN surface, in a manner that is consistent with van der Waals epitaxy. The successful growth of graphene layers depends on the substrate temperature, but is independent of the incident flux of carbon atoms. We will show also results of graphene growth by MBE on sapphire, where large area growth occurs with monolayer thickness fluctuations.
These results are consistent with a Van der Waals growth mode of graphene on dielectric substrates.

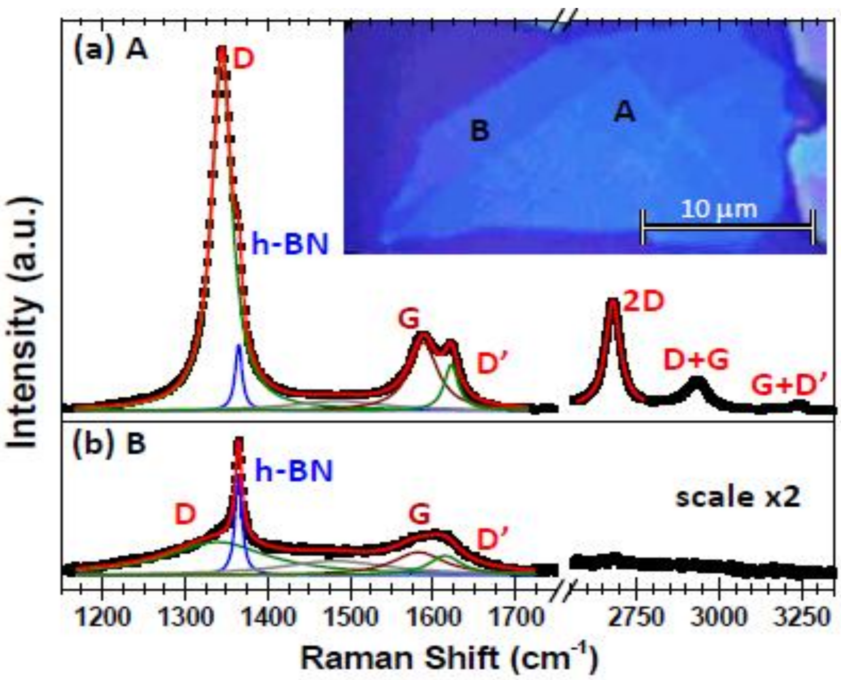

Figure 1: Raman analysis of MBE graphene on a h-BN flake, grown at T_{Growth}=930°C. (a) Spectrum from position A showing the distinctive Raman signatures of single-layer graphene . The inset shows an optical microscope image of the flake. (b) Spectrum from position B, interpreted as coming from low quality graphitic layers.

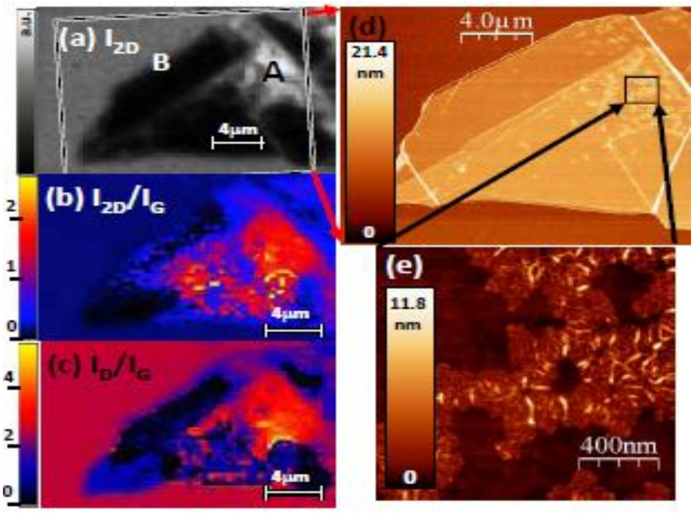

Figure 2: Raman and AFM images of the flake in the inset of Fig. 2(a). The spatial resolution of the Raman maps is 0.5 µm. (a) Map of the integrated intensity of the 2D band. (b) Map of the integrated intensity ratio of the D and G bands. (c) Map of the integrated intensity ratio of the 2D and G bands. (d) 20x15.6 µm 2 AFM image. (e) 1.5x1.5 µm 2 AFM image of the region A area showing the single-layer graphene nanodomains. Height profiles reveal that the bright elongated areas are graphene wrinkles.

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[1] Jorge M. Garcia, Ulrich Wurstbauer, Antonio Levy, Loren N. Pfeiffer, Aron Pinczuk, Annette S. Plaute, Lei Wang, Cory R. Dean, Roberto Buizza, Arend M. Van Der Zande, James Hone, Kenji Watanabe, Takashi Taniguchi, Sol. Stat. Commun. **152**, 975 (2012).

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