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Lateral graphene/h-BN heterostructures from chemically converted epitaxial graphene on SiC (0001)

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Graphene has attracted a great deal of interest due to its remarkable properties, but as a zero-bandgap semimetal its full potential for next generation electronic devices is yet to be realized. Unlocking its potential for future applications in nanoelectronics will depend critically on the development of novel approaches to introducing a bandgap while preserving carrier mobility. In-plane heterostructures of graphene and its insulating analogue, h-BN, have been predicted to allow tuning of the bandgap and carrier mobility according to the carbon concentration [1]. Such hybrid structures have previously been synthesized by CVD on metal foils, and patterned using photolithography/reactive ion etching followed by a second growth step, before transfer onto insulating substrates [2].

In this research lateral graphene/h-BN heterostructures are grown on directly on 6H- and 4H-SiC (0001) by topological conversion of epitaxial graphene. Graphene can be chemically converted to h-BN upon heated exposure to ammonia (NH3) and boric acid (H3BO3) vapors, and the concentration of h-BN can be controlled by limiting the reaction time [3]. By x-ray photoelectron spectroscopy (XPS) and scanning tunneling microscopy (STM), we observe the substitution of h-BN domains in the epitaxial graphene layer. The reaction nucleates at defects or functionalized carbon atoms which we confirm by Raman spectroscopy. This technique allows the growth of semiconducting hybrid atomic layers with tunable properties directly on a substrate suitable for device fabrication.

[1] Wang, J., et. al., Small 9(8) 1373 (2013)
[2] Liu, Z., et. al., Nat Nanotechnol 8(2) 119 (2013)
[3] Gong, Y., et. al., Nat Commun 5 3193 (2014)

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