Crystallographically Anisotropic Etching of Graphene

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We report crystallographically anisotropic carbothermal etching of graphene on SiO_2 substrates in an argon gas flow at atmospheric pressure. The samples were prepatterned with antidot lattices by electron beam lithography and reactive ion etching. The hexagonal form of the antidots obtained by the carbothermal reaction

$$\mathrm{SiO_2(s)} \ + \ \mathrm{C(s)} \ \rightarrow \ \mathrm{SiO(g)} \ + \ \mathrm{CO(g)}.$$

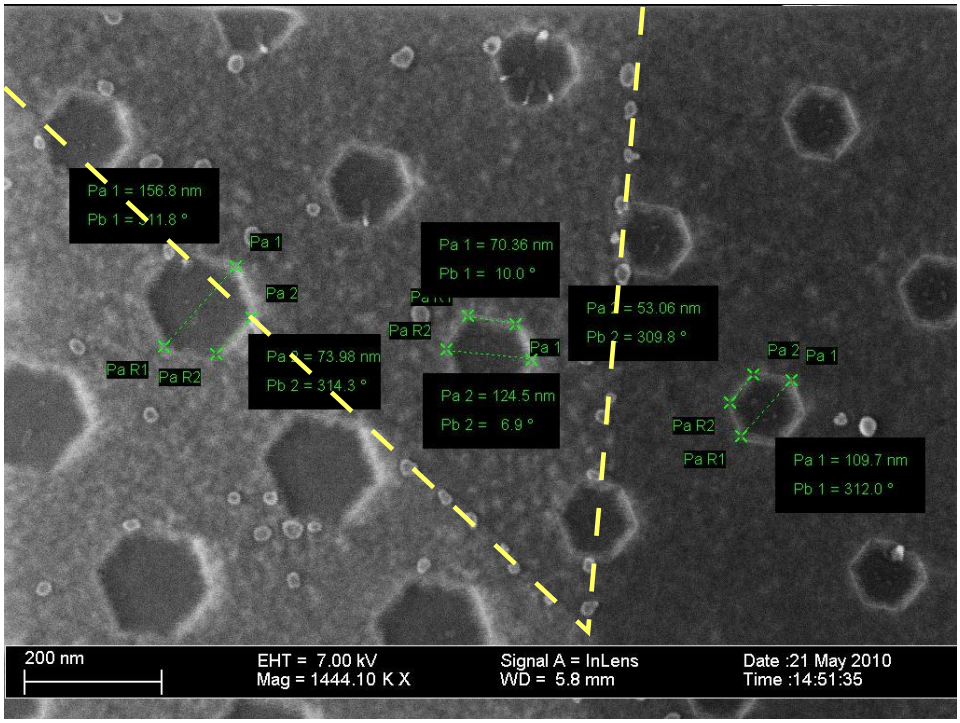
suggests the absence of armchair edges [1]. The anisotropic process could provide access to the highly interesting physical properties of zigzag-edged graphene structures. We further studied the dependence of the etching rate on the number of graphene layers. In all samples rates decreased with increasing layer thickness.

Furthermore we conducted electron transport measurements on a set of single- and bilayer samples patterned by lattices of hexagonal antidots. From temperature dependent investigation of the clearly resolved weak localization peak we deduce the phase coherence length as well as lengths for inter- and intravalley scattering. The samples exhibited good quality and phase coherence lengths of even 1µm at 1.7K despite the etching processes. Carrier mobilities up to 8000cm^2/Vs at 1.7K and Shubnikov de Haas oscillations were observed.

Reference

[1] P. Nemes-Incze, G. Magda, K. Kamarás, and L.P. Biró, Nano Research **3** (2010) 110-116

Figure



Typical appearance of antidot lattices in graphene samples after the crystallographically anisotropic carbothermal reaction. The left-hand side of the flake is bilayer graphene, the center part is four-layer and the right-hand side six layer. After prepatterning the antidots by reactive ion etching their diameter was about 45nm. The etching process grew the antidots to diameters of about 157nm, 125nm and 110nm in the two-, four- and six-layer system, respectively.