Graphene-Si(111) thin film heterostructure by aluminum-induced crystallization

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Abstract

One of the key reasons for the vast attention graphene has received recently, is its claimed potential to replace Si and Si-based electronics. However, an interesting and less explored area is the combination of graphene and Si into new hybrid materials and devices. Several examples[1,2] of combinations exist that exploit heterostructures of Si and graphene, but these examples generally combine transferred graphene with conventionally grown crystalline Si.

We here report on a new heterostructure comprised of graphene and a thin film of polycrystalline Si (p-Si). The Si is deposited by Al-induced crystallization (AIC) of amorphous Si (a-Si) on top of graphene, resulting in [111]-oriented Si under the process conditions employed. This method has previously been used for the deposition of p-Si on glass substrates[3]. X-ray diffraction (XRD), atomic force microscopy (AFM) and Raman scattering have been used to study the orientation and crystal structure of these layers. It is found that the AIC of Si on graphene is of higher quality compared to that on a SiO_2/Si(100) substrate, resulting in a more sharp Si(111) peak in XRD. The graphene/p-Si heterostructure can be easily exfoliated from the Si(100) substrate, making it possible to study the Raman spectra of both materials in the same area through the transparent graphene. Raman measurements show that the graphene is intact after the AIC process, retaining its characteristic phonon spectrum without any appearance of the D peak. In addition, a red shift of Raman peaks is observed for graphene (which is more pronounced for the 2D peak) and p-Si. A correlation between the red shifts of the Raman peaks of Si and graphene indicates an epitaxial relationship between the p-Si and graphene[4].

References

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Figures

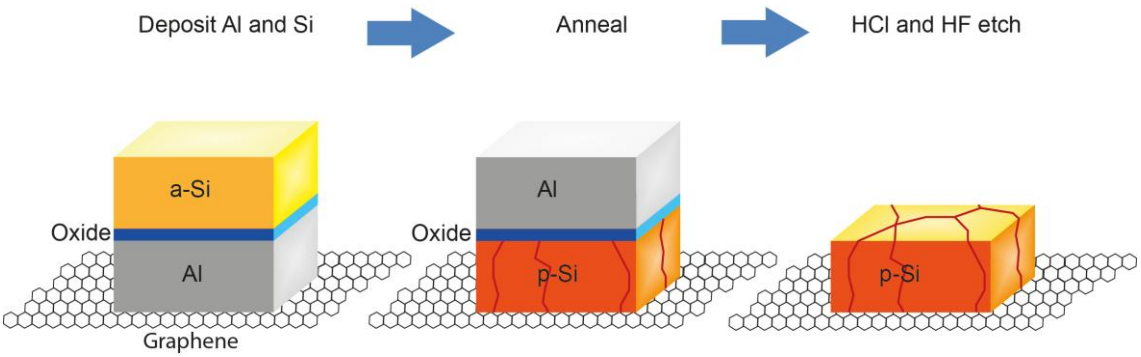

Figure 1: The main process steps of Al-induced crystallization of Si on graphene, where amorphous Si diffuses through an Al metal contact by thermal activation. At the graphene-Al interface the Si rearranges into a polycrystalline Si structure with [111]-orientation.