

Growth and Intercalation of Graphene on Germanium for Transfer Free Device Integration

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Abstract

Catalytic chemical vapour deposition (CVD) of graphene is the most promising technique for scalable integration into devices [1,2]. The recent development of graphene growth on Germanium could offer a CMOS compatible processing pathway [3]. However, graphene on Ge cannot be used directly in most applications, as electronic decoupling from the semiconductor substrate is required. The alternative route via graphene transfer degrades the interface and graphene film quality.

Here we show a transfer and metal free graphene integration pathway by decoupling graphene from the Ge substrate by the selective growth of a dielectric at the graphene-Ge interface. Such intercalation was a major advance for graphene on SiC, allowing the electronic coupling between graphene and growth substrate to be altered [4].

We have evaluated various intercalation approaches to minimise graphene strain and doping. Under optimised intercalation conditions the compressive strain of graphene resulting from the thermal expansion coefficient mismatch on Ge can be relaxed and intrinsic, low doping graphene can be obtained (Figure 1). Further angle-resolved photoemission spectroscopy (ARPES) measurements show that after intercalation the pristine graphene linear band structure is recovered and the electronic structure of quasi free standing graphene can be obtained (Figure 2).

In contrast to SiC, Ge catalysed and intercalated graphene can be performed on Si/Ge epitaxial layers so it is therefore significantly lower in cost and can readily be scaled to existing Si wafer sizes and processes.

References

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- [2] Braeuninger-Weimer, et al., Chem.Mater, 28 (2016) 8905
- [3] Lee, et al., Science 344 (2014) 6181
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Figures

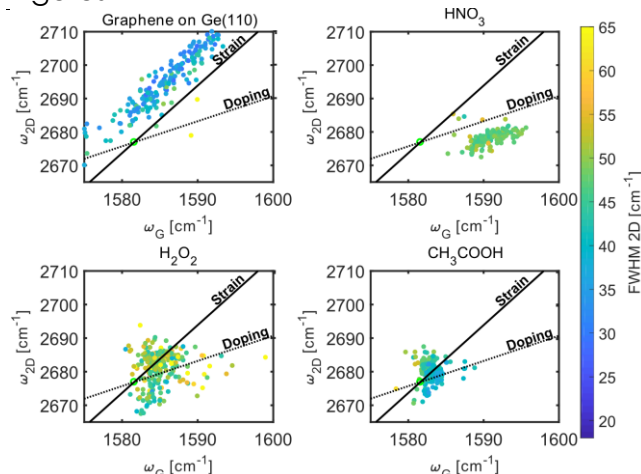


Figure 1: Scatter plot of Raman G and 2D position after CVD graphene growth and intercalation using various approaches.

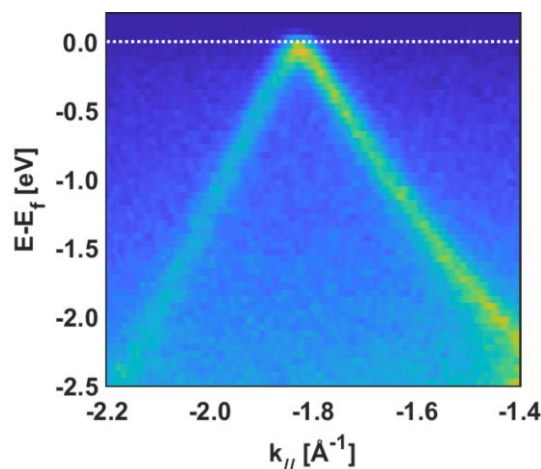


Figure 2: ARPES signature of graphene after CVD growth on Ge and intercalation.