

Optimized Graphene Growth on Ge(100)/Si(100) Substrates

*I. Pasternak¹, I. Jozwik¹, M. Lukosius², Y. Yamamoto², A. Przewloka¹,
G. Lupina² and W. Strupinski¹*

¹ Institute of Electronic Materials Technology, Warsaw, Poland, iwona.pasternak@itme.edu.pl

² IHP, Frankfurt (Oder), Germany

In order to widen the range of possible graphene applications, for example in high frequency electronics, it is desirable to grow graphene films directly on arbitrary insulator or semiconductor surfaces instead of on a most commonly used copper substrate. Ideally such insulating or semiconducting layers are deposited on Si wafers used commonly in integrated circuit (IC) manufacturing. Growing graphene directly on Si wafer surface is extremely challenging due to the tendency to form carbides. This tendency is much weaker when Ge is used as the substrate instead of Si [1], which has been exploited to grow high quality graphene on Ge(110)/Si(110) wafers [2]. Here, we present for the first time a CVD growth of graphene on monocrystalline Ge(100) “virtual substrates” deposited on Si(100) wafers which is the preferred wafer orientation in the mainstream Si IC fabrication. This approach benefits from the cost advantage and manufacturing compatibility of Si(100) wafers and avoids the metal contamination problems and complexity associated with graphene transfer from Cu.

In the present work graphene films were synthesized in a 6-inch Black Magic system by the CVD method. As a substrate we used 3 μm thick (100) oriented Ge deposited on Si(100). To ensure optimal temperature conditions, thus preventing Si diffusion through a Ge layer and Ge melting the temperature was chosen in the range between 900⁰C and 930⁰C with a slow ramp. We optimized the ratio of Ar/H₂/CH₄ gases, growth time and pressure so that a continuous film was created. Furthermore, we developed the process of transferring graphene from Ge(110)/Si(110) wafers onto dielectric substrates aimed at showing clear and non-contaminated graphene films [fig. 1].

The assessment of the properties of graphene grown on Ge/Si substrates was performed using Raman spectroscopy, which confirmed the formation of graphitic structures and their quality, AFM and SEM imaging, which showed the morphology of the graphene/Ge/Si interaction. For the purpose of the contamination detection by performing the ToF-SIMS analysis, we developed a protocol of graphene transfer onto a dielectric substrate.

References

- [1] G. Lippert, et al Carbon 75, 104 (2014).
- [2] Lee et al, Science Vol. 344 no. 6181 (2014) pp. 286-289.
- [3] The research leading to these results has received funding from the European Union Seventh Framework Programme under grant agreement n°604391 Graphene Flagship.

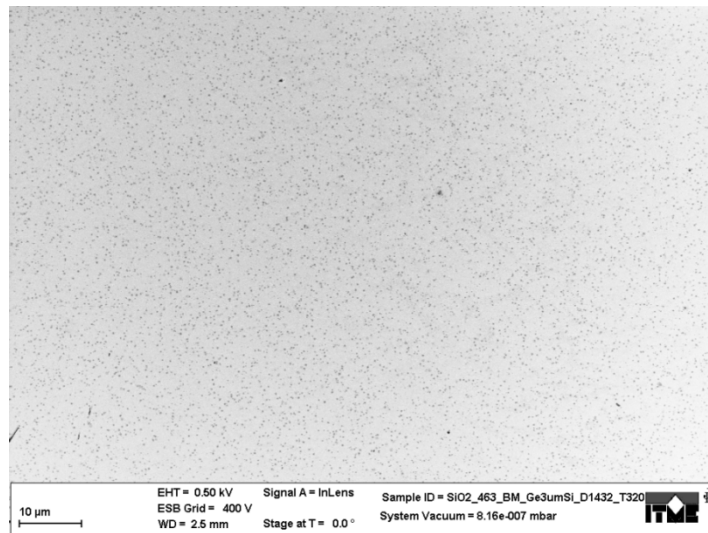


Figure 1: SEM image of graphene film transferred from Ge(100)/Si(100) wafer.