Graphene synthesis on insulating substrates via Ni-assisted CVD

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Abstract

Recent years brought significant progress in the area of graphene synthesis. However, despite the immense research efforts, a direct method for the depositions of high quality graphene on arbitrary substrates (insulators or semiconductors) is still not available (except for graphene transfer). Although transfer of graphene may be a viable option in prototyping and even some commercial applications, in microelectronic manufacturing of novel graphene based devices, a direct, clean, and simple growth on arbitrary semiconducting and insulating substrates would be ideal. In addition, such a growth method should be also scalable and compatible with the mainstream Si technology manufacturing requirements. The growth of graphene on Ni has been already investigated by several groups so far, where graphene films were synthesized via chemical vapor and solid deposition methods at elevated temperatures (~1000 °C) [1-3]. In these cases, graphene growth occurred on top of the Ni, underneath the Ni and between the Ni dots. These approaches show the potential of Ni as a mediator for graphene synthesis, and are very promising, however, there also some drawbacks, like the inhomogeneous coverage and number of layers and defects in graphene. In the present work, we examined the possibility to develop Si-technology compatible, transfer-free, Ni-mediated graphene synthesis method, since new approaches for the fabrication of graphene-based nanostructures with high quality graphene and tailored interfaces are of the highest importance. The depositions were performed at the temperature of 800 – 1000 °C, using C_2H_4 reactive gas as the source of carbon and Ar as a carrier gas. The typical pressures of 0.1 mbar were maintained during the deposition process. 50 nm Ni structures were evaporated at room temperature on Si wafers, covered with 100 nm thermally grown SiO_2. The samples were annealed in the H_2 atmosphere at 800 °C in order to crystallize Ni, followed by the exposure to C_2H_4 atmosphere for 20 minutes

Two types of graphene synthesis (underneath and between the Ni structures) routes have been investigated in this study. The first results of the attempts to grow uniform layers of graphene underneath the Ni structures are presented in Fig. 1. The experiments revealed that the graphene successfully grew on the Ni bars as well as underneath the Ni, on the insulating SiO_2 layers, as it was found by Raman spectroscopy (Fig. 3 c), after etching away the top graphene layer and the Ni film. In addition, an alternative route of growing graphene between Ni on the SiO_2 will be also presented in this work.

References

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Figures

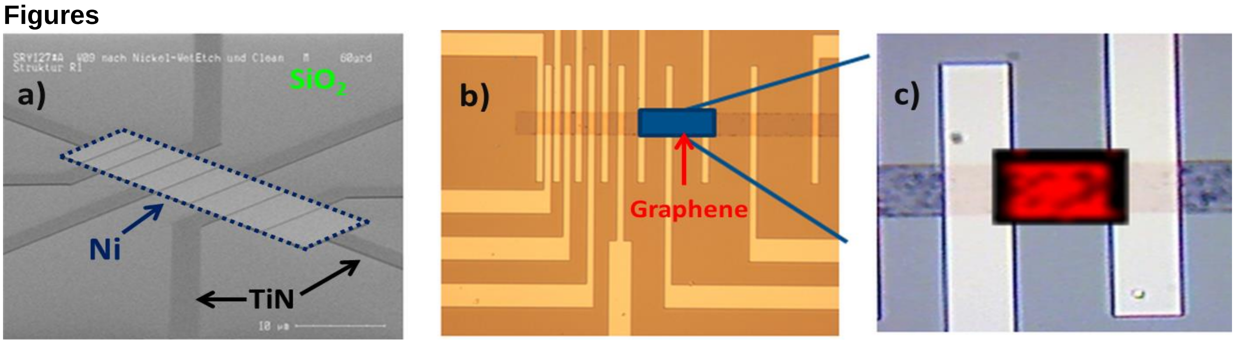

Fig. 1. SEM (a), optical microscope after Ni etch (b) and Raman mapping of the 2D intensity (c) images of the graphene, on structured Ni on SiO_2/Si wafers.