Graphene - terminated substrates for the remote epitaxy and transfer of III-V solar cells

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ABSTRACT

Graphene assisted remote epitaxy is a recently introduced method that could allow III-V substrate re-use after growth, and therefore drastically reduce the cost of the currently most efficient solar cells overcoming the limitations of current transfer-recycle techniques. When a III-V material is epitaxially grown on a graphene-terminated III-V substrate, long range ionic interactions through graphene [1] along with defect-assisted nucleation and lateral overgrowth [2] enable the transfer of crystallographic registry from the substrate to the epilayer. As the 2D interlayer prevents the formation of strong chemical bonds at the interface, lattice mismatch constraints are relaxed, and mechanical exfoliation and 2D material-based layer transfer are possible.

To synthesize single-crystal transferrable layers in this way, graphene grown on foreign substrates needs to be transferred to the target III-V substrate with a high surface coverage, thickness uniformity and cleanliness. Despite the numerous research efforts carried out during the last decade to improve graphene transfer processes, the introduction of organic residues, wrinkles, and mechanical damage with the commonly used wet-transfer methods still hinders it's use for many potential applications.

In this contribution, we investigate the dry transfer of graphene grown on Ge(110) by chemical vapor deposition to obtain graphene-covered III-V substrates suitable for remote epitaxy. We avoid organic residues by using mechanical exfoliation with a metallic carrier layer [3], while a high transfer yield and a pristine 2D-3D interface are enabled by vacuum transfer and aircushion pressing of the graphene/metal stack on the target substrate. Here we will present our improved polymer-free transfer method and the characterization of transferred samples by Raman, optical and scanning electron microscopy along with a qualitative comparison with wet-transferred CVD graphene. First GaAs growth on Graphene covered GaAs substrates will be conducted in the coming weeks and discussed at the conference.

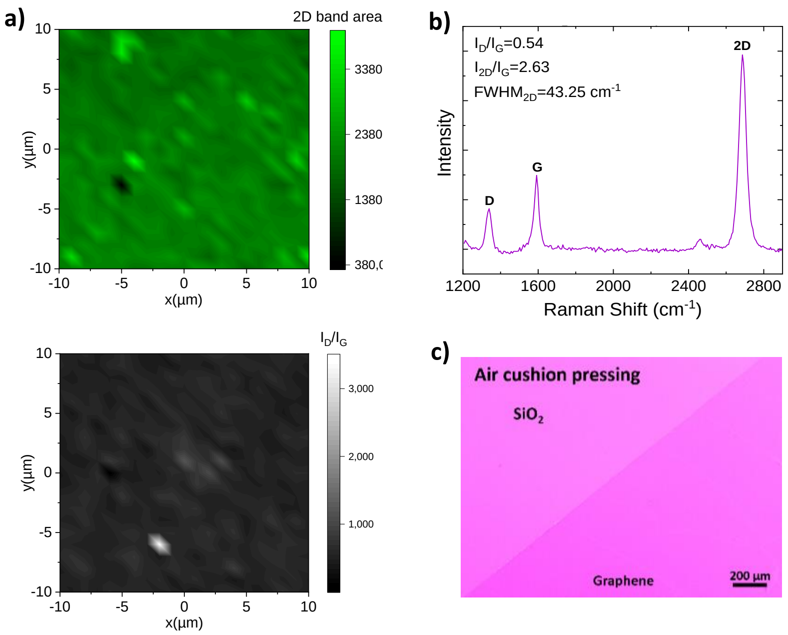

Figure 1: a) Raman maps of the 2D band intensity (top) and D to G intensity ratio (bottom) of transferred graphene. **b)** Averaged Raman spectrum, corresponding to the maps shown in a. **c)** Optical image of the sample with no visible residues or damage.

References

1. Y. Kim et al., *Nature*, vol. 544, no. 7650, pp. 340–343, 2017.
2. S. Manzo et al., *arXiv:2106.00721v2 [cond-mat.mtrl-sci]*, 2021
3. J. Kim et al., *Science*, vol. 342, Issue 6160, pp. 833-836, 2014