III-V growth on graphene covered substrates towards transferable epilayers

Carlos Macias, Naomie Messudom, Antonella Cavanna, Ali Madouri, Nathalie Bardou, Laurent Travers, Jeronimo Buencuerpo, Andrea Cattoni, Jean-Christophe Harmand, Amaury Delamarre

Institut Photovoltaïque d'Ile-de-France (IPVF), 18, boulevard Thomas Gobert, 91120 Palaiseau, France
Centre for Nanoscience and Nanotechnology (C2N), CNRS, Univ. Paris-Sud, Univ. Paris-Saclay, 10 Boulevard Thomas Gobert, 91120 Palaiseau, France

In the context of developing tandem solar cells to overcome the physical limitation of silicon single cells, III-V is a candidate material family to manufacture the top cell, providing their cost can be significantly reduced. This will require several breakthroughs, the first of them being the removal of the substrate cost, either by using low cost alternative or by recycling the costly III-V substrate.

In the latter strategy, a promising route is to take advantage of the remote epitaxy [1], which consists in growing III-V atop a graphene covered substrate, resulting in exfoliable monocrystalline epilayers. Despite proofs of concept, the underlying mechanisms have not been unambiguously clarified, preventing growth optimisation and consequently efficient devices. A possible mechanism would be a remote interaction through the graphene, by potential fluctuations generated by the underlying dipoles of the substrate. In our previous work [2], following the development of a graphene dry transfer method and exploration of growth parameters by MBE, such an effect could not be observed. We will discuss in this communication how openings in the graphene can result in local nucleation followed by lateral overgrowth.

[1] Y. Kim, et al., "Remote epitaxy through graphene enables two-dimensional material-based layer transfer," Nature 544(7650), 340–343 (2017).
[2] C. Macías, et al., in Physics, Simulation, and Photonic Engineering of Photovoltaic Devices XII (SPIE, 2023), pp. 27–33.