Metals under confinement: Unlocking room temperature intercalation of indium in epitaxial graphene

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Intercalation of foreign species into two-dimensional van der Waals materials provides a route to tailor interfacial coupling and electronic structure. In epitaxial graphene on SiC(0001), metal intercalation induces decoupling of the covalently bonded graphene zero-layer from the substrate, while the resulting confinement at the graphene–SiC interface stabilizes metallic phases with structural and electronic properties distinct from those of their bulk counterparts [1-3].

Here, we show that indium intercalation beneath epitaxial graphene already occurs at room temperature, despite the bulk melting point of indium being 157 °C. Time-resolved microscopy reveals a laterally propagating intercalation front that follows the SiC terrace morphology, consistent with gallium intercalation [4], and strongly evidences anisotropic mass transport. SPA-LEED, Raman, and ARPES indicate the formation of a structurally ordered confined indium phase and the conversion of epitaxial graphene into quasi-freestanding bilayer graphene (QFBLG). Our observations can be described within a thickness-dependent thermodynamic framework, in which both the chemical potential of confined indium, driven by relaxation of epitaxial graphene, and the imbalance between the In/SiC and In/graphene interfacial energies promote intercalation.

References:
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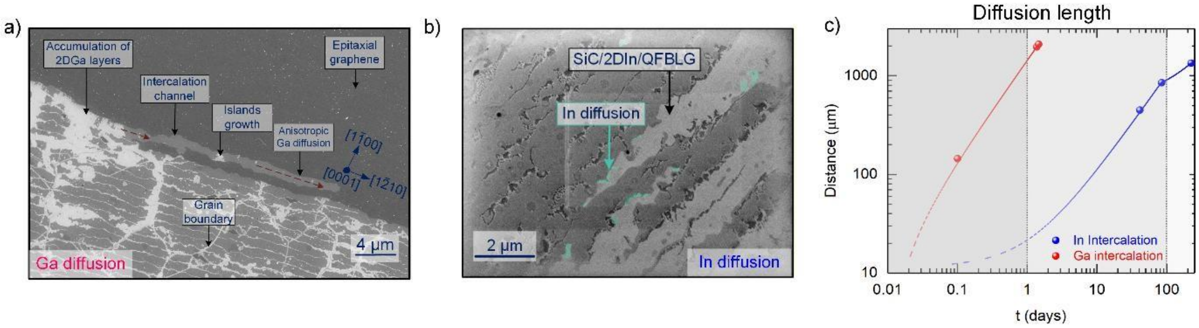

Fig. 1: Time-resolved microscopy of room-temperature metal intercalation beneath epitaxial graphene on SiC(0001). **a, b)** Microscopy images showing anisotropic lateral propagation of the intercalation front along the SiC terraces for Ga and In, respectively. **c)** Time-dependent evolution of the diffusion length, highlighting the distinct intercalation behavior of indium compared to gallium.