Molecular Beam Epitaxy of 2D Materials for Deep-UV Optoelectronics

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Wide bandgap semiconductors have become increasingly important due to their optical properties in the deep-UV range (UV-C, 200-280 nm). 2D materials provide opportunities to integrate UV-C optoelectronics on diverse platforms, however producing high-quality layers is still challenging. Here, we demonstrate epitaxial growth of hexagonal boron nitride (hBN)[1] and gallium selenide (GaSe)[2] by molecular beam epitaxy (MBE) as a route to scalable integration of wide bandgap semiconductors for deep-UV optoelectronics.

Step flow growth of hBN on highly oriented pyrolytic graphite (HOPG) by high-temperature MBE can produce monolayers and multilayers with micron-sized single-crystal domains. The hBN layers have high optical quality and exhibit deep-UV luminescence at 205 nm.[3] Additionally, hBN can be intentionally carbon-doped to induce single photon emission,[4] and by low-temperature scanning tunnelling microscopy (LT-STM) we observe atomically precise few-atom carbon substitutions, shedding light on the atomic structure of single photon emitters in hBN.

We also demonstrate growth of a new GaSe polymorph (γ'-GaSe) by MBE on epitaxial graphene/SiC and 2-inch sapphire wafers. Through *in situ* STM and angle-resolved photoemission spectroscopy (ARPES), we observe the layer-dependent valence band dispersion of 1-6L γ'-GaSe grown on epitaxial graphene. γ'-GaSe grown on sapphire exhibits resonant UV-C absorption (λ = 260 nm) which we exploit for highly sensitive photodetection.[2]

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