Alternative strategy to grow large surface hBN on Ge films by Molecular Beam epitaxy

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Hexagonal Boron Nitride is a two-dimensional insulator with a wide bandgap (~6 eV), chemically and thermally stable. Its 2D nature makes it exceptionally interesting as an ultrathin barrier, tunneling or passivation layer for integrated electronics and photonics, noticeably for the encapsulation of graphene or other 2D materials for next generation electronics [1]. In the case of germanium, Ge oxides are unstable and might induce thermal pits, limiting its applications [2]. Hence, hBN could be a good candidate not only for Ge passivation but also for ultra-capacitors (e.g., metal/hBN/Ge) and for graphene devices on Ge (e.g. graphene/hBN heterostructures)[1,3].
In this work, we study the growth of large surface atomically thin hBN on Ge (001) films by molecular beam epitaxy using boron effusion cell and a remote nitrogen plasma cell. Firstly, we discuss how the B/N precursor ratio influences the BN composition from B-rich to stoichiometric films (figure 1). Then, we consider the challenges related to the limitation of growth temperature due to Ge thermal pits formation. A BN buffer layer strategy was developed which significantly allows to increase the growth temperature without thermal pits formation, so that better quality BN can be grown.

References

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[2] Diallo, T.M., et al. , 'CVD Growth of High-Quality Graphene over Ge (100) by Annihilation of Thermal Pits', Carbon 174 (2021), 214–26
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Figures

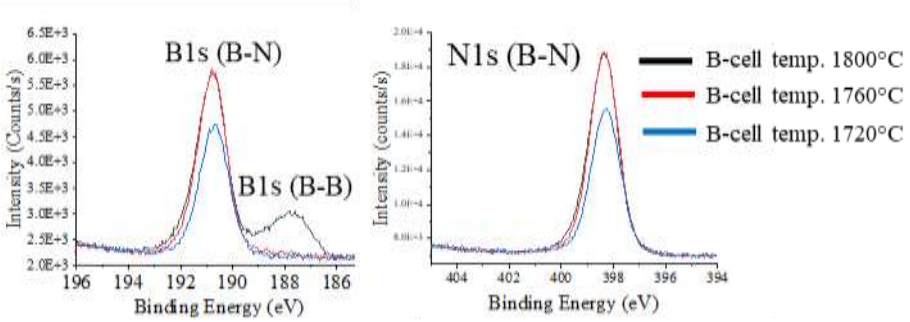

Figure 1: XPS measurements of BN grown as a function of the B-cell temperature (i.e., B flux), B1s (left) and N1s (right) components. BN films are B-rich above 1760°C, and stoichiometric below 1760°C.