Opportunities for sp^2-hybridized Carbon Nitride

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A widespread interest is currently emerging in graphitic carbon nitride, which consists of covalently-linked, sp^2 hybridized carbon and nitrogen atoms in an alternating fashion [1]. It is suggested to be 2D material of inherent semiconductivity with band gap of between 1.6 and 2.0 eV [1]. Therefore, it will enable the development of bang gap engineered device applications at the 2D limit.

We present here evidences of sp^2 hybridized carbon nitride resulting from metalorganic chemical vapour deposition (MOCVD) experiments at various temperatures, which were originally designed to tailor the surface treatment of the SiC substrate before the deposition of AlN epitaxial layers [2, 3]. The overall heteroepitaxial stack is accomplished in a continuous process under characteristic MOCVD process implementing the principal precursors ammonia and trimethylaluminum [4]. The low process pressure of 50 mbar is prompted to promote a low supersaturation of the SiC vapor over the heated substrate surface. Further control of the appearance of the substrate surface relates to the implementation of high process temperature of 1250^{o}C, and up to 1450^{o}C, coupled together with the etching effect of the hydrogen carrier gas, and furnished further by the exposition of the SiC substrate surface to ammonia. Ammonia is introduced at the end of the temperature ramping step and ahead of the TMAl introduction. It is known to give rise to surface effects including nitrogen chemisorption.

Topographic and phase AFM [5] analysis shows step-bunched wide terraces with characteristic domains interspersed along the steps and of apparently different material. The domains with lateral size of tens-of-nanometers originate from the intervening SiC substrate treatment. The heteroepitaxial stack is analyzed by high resolution scanning TEM (HR-STEM) and local electron energy loss spectroscopy (EELS). The domains were identified as sp^2 hybridized carbon nitride.

Looked upon from a different perspective, our findings may also have implications for managing significantly better any successful epitaxial growth of AlN (group III-Nitrides) on SiC supported graphene templates for electronic devices, including in the context of managing significantly better the heat dissipation in the devices operating under high currents, i.e. the group III-Nitrides based LEDs [6].

References

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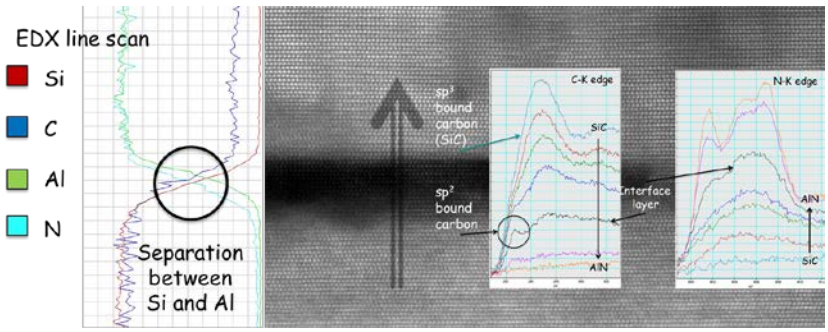

Figure 1: sp^2 hybridized carbon nitride at the AlN/SiC interface in MOCVD process at 1400^oC by HR-STEM and local EELS.