Optical properties of carbon-doped hexagonal boron nitride

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Hexagonal boron nitride (h-BN) continues to be one of the most extensively researched 2D materials, its excellent chemical stability thermal conductivity and vast potential applications in deep-UV optoelectronics as a wide-gap semiconductor, or in van der Waals heterostructures. However, its use is limited due to difficulties in growing large-scale, high-quality layers as well the lack of ohmic contacts.

In this communication we study the effects of carbon doping on the optical properties of epitaxial hexagonal boron nitride, grown by using Metalorganic Vapor Phase Epitaxy (MOVPE). Carbon can be introduced into the sample with ease by using nitrogen in place of hydrogen as carrier gas, which was confirmed by EDX spectroscopy, and quantitative control over the carbon content can be by manipulation of precursor ratio and growth temperature.

The effects of variable carbon content in samples was studied using Raman, FTIR and UV-Vis spectroscopy. The measurements showed significant differences in the structure as well as in the bandgap energy.

Cathodoluminescence (CL) measurements at room temperature were also performed, showing a peak around 340 nm in all samples with its intensity varying greatly across all samples. We observed that low carbon content correlates with high CL intensity. Furthermore, an increase in peak intensity was measured on triangular flakes on the samples' surfaces, suggesting a non-uniform growth mode and carbon incorporation.

Understanding the effect of carbon incorporation on the growth and properties of h-BN is crucial to its effective use in optoelectronics.

Acknowledgments: This work was partially supported by the National Science Centre of Poland, grants no 2019/33/B/ST5/02766, 2020/39/D/ST7/02811, 2021/41/N/ST7/04326