Investigating the Proximity Effect in h-BN/ 2D Magnet Heterostructures

Katarzyna Ludwiczak[1], **Johannes Binder**[1], **Aleksandra Krystyna Dąbrowska**[1], **Piotr Tatarczak**[1], **Joanna Sitnicka**[1], **Jacek Jasiński**[2], **Roman Stępniewski**[1], **Andrzej Wysmołek**[1]

[1]*University of Warsaw, Pasteura 5, 02-093 Warsaw, Poland;*
[2]*University of Louisville, 2301 S 3rd St, Louisville, KY 40292, United States of America*

Hexagonal boron nitride (h-BN) is a two-dimensional crystal widely used in layered materials research due to its flat surface, high chemical stability, and lack of dangling bonds. Recent advances in the study of color centers in h-BN have made it an excellent platform for investigating basic physical phenomena, including optically addressable spin defects, rendering it a promising candidate for quantum technologies [1].

We focus on the growth of high quality h-BN samples using Metalorganic Vapour Phase Epitaxy (MOVPE) technique. The samples are grown on large (~2 inches) sapphire substrates and cover them uniformly [2,3]. This method allows us to engineer material parameters such as its thickness, structure and consequently - type and concentration of defects. We observe emission from colour centres in epitaxially grown h-BN at different energies, indicating the presence of various defects, like boron vacancies or carbon-related defect complexes.

In this study, we explore the proximity effect between h-BN and 2D magnets (e.g. chromium trihalides). Such an approach enables the investigation of paramagnetic centres in h-BN using locally applied magnetic fields. We studied the photoluminescence of h-BN/$CrBr_3$/h-BN heterostructures and found an additional peak in the spectrum at low (liquid helium) temperature. We believe that the optical response is correlated with the magnetic ordering in $CrBr_3$ crystals (Fig 1).

In the future, the creation of such heterostructures can become feasible using a subsequential growth of 2D magnets on top of the h-BN epitaxial layers [3]. Such an approach could be a reliable solution for scaling up ultrathin heterostructures and allowing their future development for real-life applications.

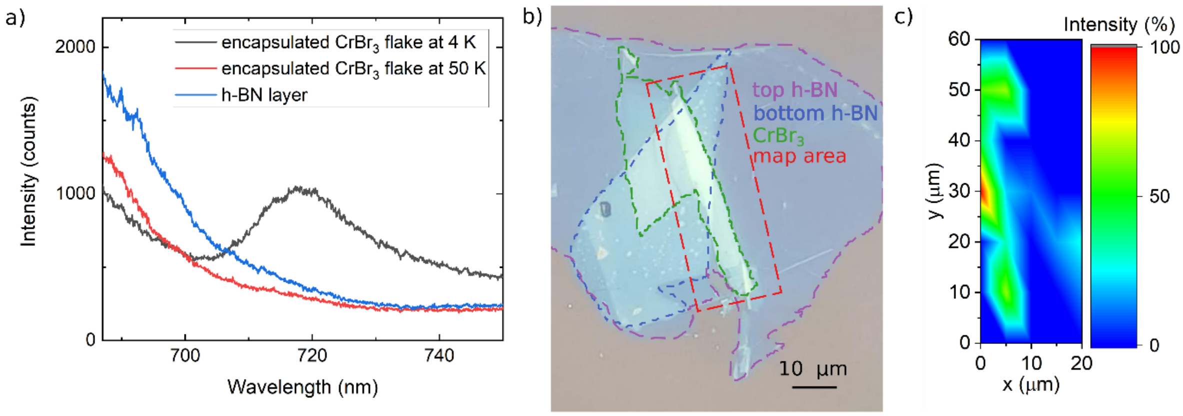

Fig. 1. a) Photoluminescence spectra of a h-BN/$CrBr_3$/h-BN heterostructure. b) Optical microscope image of the studied heterostructure. c) Intensity (peak area) map of the additional photoluminescence peak of the studied heterostructure.

This work was supported by the National Science Centre, Poland under decisions 2019/33/B/ST5/02766, 2020/39/D/ST7/02811 and 2021/41/N/ST3/03579.

[1] A. Gottscholl, et al., *Nature Materials* **19,** 540 (2020)

[2] A.K. Dąbrowska et al. *2D Mater.*, **8**, 015017 (2021)

[3] K. Ludwiczak et al., *ACS Appl. Mater. Interfaces* (2021), **13(40):** 47904–47911