Semi-Layered Metal Diborides
Liquid Exfoliation and Processing of Metallic non-Van der Waals Crystals

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Owning to their unique material properties, the field of two-dimensional materials is getting ever-growing attention. This can be attributed to their surface chemistry and high surface to volume ratio, as well as arising quantum effects, when going from bulk solid to the monolayer limit.[1,2] While more and more reports on the exfoliation of novel 2D materials with promising properties and interesting transport characteristics have been presented over the past decade, only few examples of metallic or semi-metallic 2D materials have successfully been exfoliated into nanosheets, especially in liquid processable media, offering scalable device fabrication.

In this contribution, a scalable exfoliation method for three different, commercially available, semi-layered metal diborides (CrB_2, MgB_2 and ZrB_2) is presented, using a novel approach of liquid phase exfoliation in inert atmosphere. This allows to fabricate nanosheet dispersions in versatile liquid environments, while established centrifugation-based protocols are used to remove initially oxidised starting material from the nanosheets and for size selection.[3,4]
After successful exfoliation, a modified Langmuir Schaefer deposition technique was used for processing the nanomaterial into tiled thin-film networks, revealing metallic conductivity of the nanosheet network. The deposited nanomaterial is characterised electrically and spectroscopically, and changes of the film characteristics are followed over time to provide insights in the sample degradation after exposure to ambient conditions. At last, oxidation preventive working procedures are presented.

References

[1] Fu, Q., *et al.*, Chem. Soc. Rev., 46 (2017), 1842-1874
[2] Backes, C., *et al.*, Nat Commun, 5 (2014), 4576-4586
[3] Synnatschke, K., *et al.*, Chem Mater, 31 (2019) 9127-9139
[4] Backes, C., *et al.*, ACS Nano, 10 (2016), 1589-1601

Figures

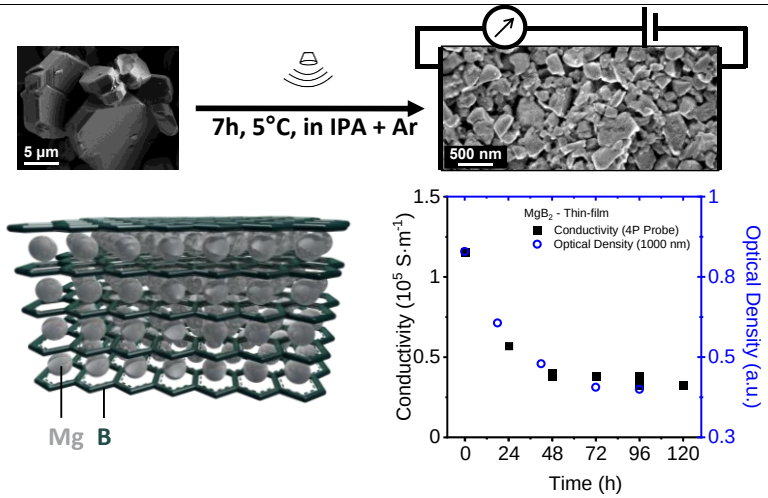

Figure 1: Schematic illustration of the processes addressed within the scope of this report. Liquid phase exfoliation and thin-film preparation from MgB_2 bulk crystallites. Thin films are contacted, and transport characteristics are studied over time.