# Supplementary Information

## Calibration of thickness measurement

As pointed out in the main body of the text, due to the hydrophilic character of the $SiO_2$ surface, it tends to absorb water and results in a typically 1 nm-thick water layer captured between $SiO_2$ and BN. As for graphene, this complicates the thickness measurements of atomically-thin BN flakes by the AFM technique. Indeed we have observed that the water layer thickness is relatively inhomogeneous over the wafer, which induces a strong inaccuracy in determining the thickness of few-monolayer flakes by AFM. Thickness measurement by optical contrast (OC) imaging under visible light illumination is then preferred in this work, because it appears to be less perturbed by the presence of water. By using Differential Interference Contrast microscopy (DIC), the OC was first calibrated with AFM measurements specifically taken on BN flakes having folded parts. This ensures the step height between the folded part and the unfolded one, to be independent on the amount of water trapped between hBN and $SiO_2$.

To that end, a Dimension 3100 scanning probe microscope from Brukers company equipped with commercial MPP11-100 AFM tips was used in tapping mode. The OC was measured with the same parameters (filters, exposure time) for two folded flakes deposited onto the $SiO_2$/Si substrate as shown in FigS1a and S1b. The values are plotted as a function of the number of layer measured by AFM in Figure S1c. We observe a linear dependence of the OC on the hBN thickness up to 20L, with approximately 1.5% of contrast per layer in good agreement with the literature [1] much lower than the ∼% OC of graphene [2]. It is remarkable that the OC line crosses the axis at 0L, which confirms the small dependence of OC-based thickness measurements on the presence of water. Considering the small thickness of the water layer (1nm) compared to the $SiO_2$ thickness (90 nm) and the small refractive index difference between $SiO_2$ (1.45) and water (1.33) compared to hBN (1.8), the contrast measurement appears to be robust upon water contamination and allows a more accurate thickness determination than AFM for hBN thicknesses below 20L-6 nm.

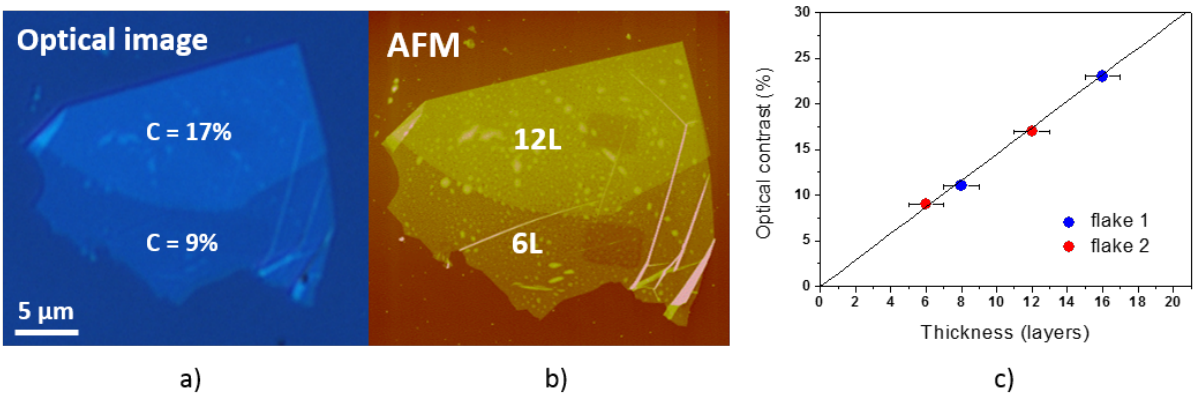


Figure S 1: a) DIC optical and b) AFM images of hBN folded flake. c) Calibration plot of the optical contrast (OC) as a function the thickness measured by AFM for two folded hBN flakes.

## The low-dimensionality effect is not sample-dependent

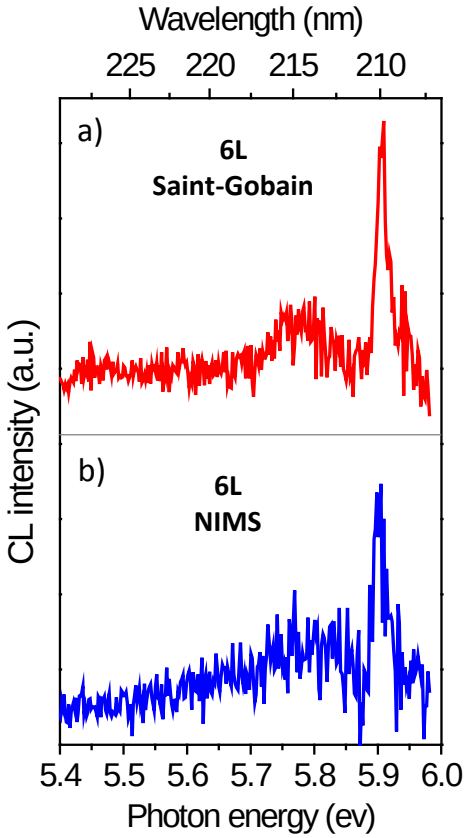


Figure S 2: CL spectra of 6L mechanically exfoliated hBN flakes obtained from a) Saint-Gobain powder b) NIMS sample. Spectra are corrected from the spectral response of the detection system.

# AFM characterization of thin hBN flakes

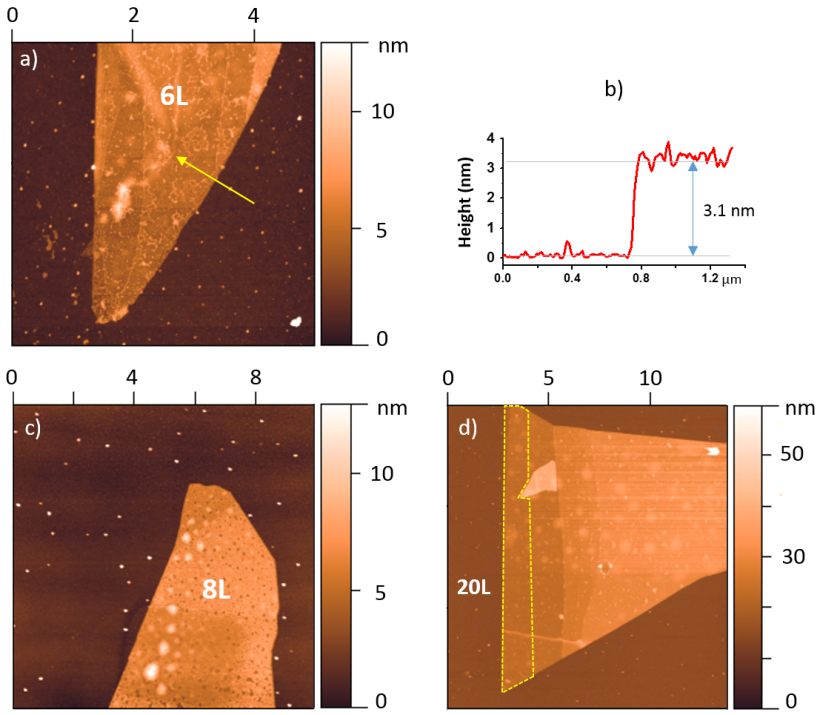


Figure S 3: AFM images of exfoliated hBN layers transferred onto a $SiO_2$/Si substrate composed of : a) 6L c) 8L and d) 20L. The image size unit is micrometer. Profile taken across the part of the 6L flake along the arrow is shown in b). The OC indicates a 6L thickness while AFM exhibits 3.1 nm height revealing a 1nm water layer thickness trapped between hBN and $SiO_2$.

## References


[1] R. V. Gorbachev et al., *Small*, 465-468 (7), 2011.

[2] P. Blake et al., *Applied Physics Letters*, 14-17 (91), 2007.