System independent method to identify layer numbers of 2d materials from optical images

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Optical contrast methods to identify layer numbers of two-dimensional (2D) materials are based on the intensity ratio between the 2D flake (MoS_2, WSe_2, graphene) and substrate at specific imaging configurations [1]. In this study, we show that the intensity ratios for monolayer (ML) and few layers drastically change between different imaging systems (Figure 1a). We suggest a new optical image-based technique for layer identification by using the slope of flake vs. substrate intensities with varying lamp power (Figure 1b). Remarkably, for the red-green-blue (RGB) format, these intensity slopes are consistent across different imaging systems (Figure 1c), whereas the intercepts are different. Different intercepts values result in different intensity ratios. In the case of RAW images, the intercept is zero, which makes the intensity slope and ratio the same (Figure 2a). A Fresnel-reflectance-based optical model is used to calculate and verify the experimentally found RAW intensity ratio values (Figure 2b). From the high robustness of our method, in terms of the imaging system used, or the 2D materials, we propose that intensity slopes (for RGB or RAW) or intensity ratio (for RAW) can be used as a universal parameter to identify and confirm layer numbers.

References

[1] L Ottaviano *et al, 2D Mater.* **4** (2017) 045013

Figures

Figure 1: (a) & (c) Intensity ratio & slope of different layered regions (ML/BL/TL: mono/bi/tri-layer) from images of MoS_2 on 285nm SiO_2/Si. **(b)** RGB images of MoS_2 flake (S, substrate) with increasing light intensities.

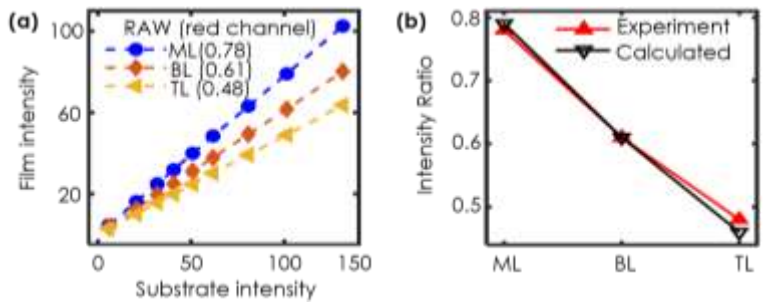

Figure 2: (a) Intensity variation for RAW images, respective slopes (same as ratio) are mentioned in the legend. **(b)** Comparison between calculated and experimentally found intensity ratios.