Understanding Flake Size Separation during Centrifugation

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Liquid phase exfoliation is a powerful tool for the preparation of 2D nanomaterial inks and dispersions that can be used for a wide range of applications. [1] While such dispersions have enormous potential because of their flexibility, their polydispersity is an intrinsic drawback. [2] Centrifugation has been widely applied to separate flakes of different sizes while maintaining the easily processable dispersion; however, the centrifuge conditions required are still poorly understood and trial and error is usually required to optimise the desired flake size. [3] We have developed a model, balancing the complex shapes and sizes of nanoflakes with the need for suitable ensemble parameters, to predict the behaviour of dispersions under centrifuge conditions. Assuming regular rhombus flakes and using previously measured surfactant binding, the density and friction of the nanosheets can be expressed. [4] This theoretical model has been successfully applied to transition metal dichalcogenides (Figure 1). With this model it should be possible to identify the exact centrifuge conditions required for different sized nanoflakes and simplify the purification required from polydisperse samples commonly prepared from liquid phase exfoliation.

References

[1] Bonaccorso et al., Adv. Mater.,28, (2016), 6136-6166
[2] Claudia Backes et al., ACS Nano, 13, (2019), 7050–7061
[3] Claudia Backes et al, ACS Nano, 10, (2016), 1589-1601
[4] M. Arnold et al., *ACS Nano*, 2, (2008), 2291-2300

Figures

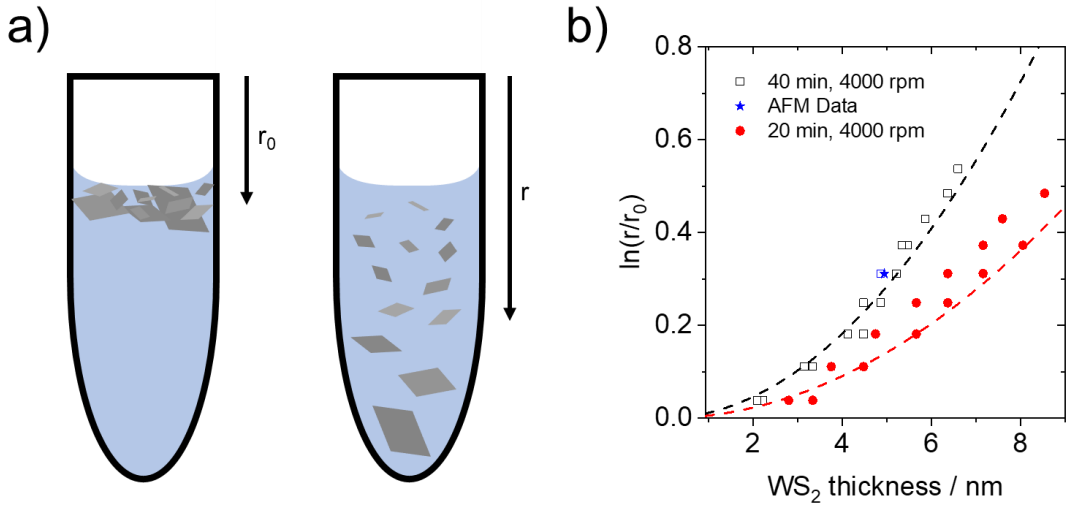

Figure 1: a) Schematic of band sedimentation process to separate nanoflakes according to size. b) Measured distribution of tungsten disulphide flake sizes down centrifuge tube matching the theoretically predicted distribution (dashed lines).