

Green route for production and biofunctionalization of transition metal dichalcogenides based nanosheets

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Abstract

Recently, two dimensional (2D) materials including transition metal dichalcogenides (TMDs), such as MoS₂ and WS₂ have triggered the enthusiasm of the research community due to their extraordinary chemical, electronic and optical properties. Moreover, the wide spectrum of their applications in nanoelectronics, nanophotonics, biomedical and sensing devices, has also motivated research on the production of high quality 2D TMDs. Literature reports suggest that these layered materials are produced by various techniques such as mechanical and chemical exfoliation, including liquid phase exfoliation [1], being the most versatile technique for the production of large-scale, few-layered and functionalized 2D TMD based nanosheets.

Herein, we report that during liquid exfoliation of MoS₂ and WS₂ layered crystallites are sonicated in presence of green solvents i.e., water and ethanol and a fungal hydrophobin Vmh₂ [2] is added to retain stability and biological functionalization. Since, Vmh₂ protein has unique physicochemical properties and superior hydrophobicity, the addition of this hydrophobin results in stable dispersions of few/monolayered nanosheets, after few steps of controlled centrifugation. Furthermore, controlled centrifugation enables the selection of bio-functionalized few-layered nanosheets of MoS₂ and WS₂, which are investigated by UV-VIS, Raman spectroscopy and atomic force microscopy. The stability of these dispersions are studied by zeta potential measurements, which also confirm the bio-functionalization of nanosheets. Thus, we have introduced an eco-friendly and economic strategy to produce large scale and biofunctionalized TMD based nanosheets.

References

[1] V. Nicolosi, M. Chhowalla, M.G. Kanatzidis, M.S. Strano and J.N. Coleman, *Science* 340 (6139), (2013), 1226419.

[2] A.M. Gravagnuolo, E.M. Narváez, S. Longobardi, E.T. Silva, P. Giardina and A. Merkoçi, *Adv. Funct. Mater.*, **25**, (2015), 2771.

Figures

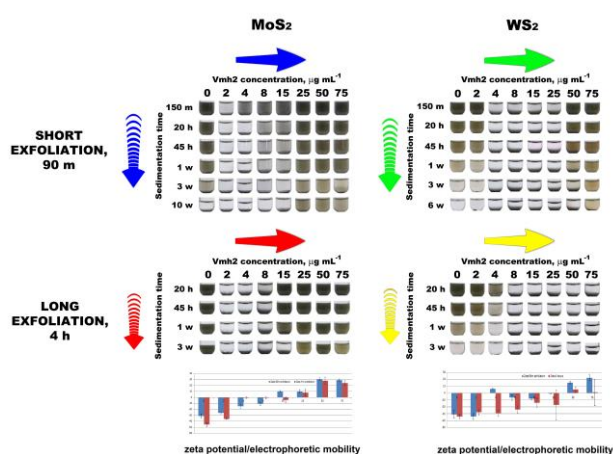


Figure 1 Stability of exfoliated samples in function of time and hydrophobin content

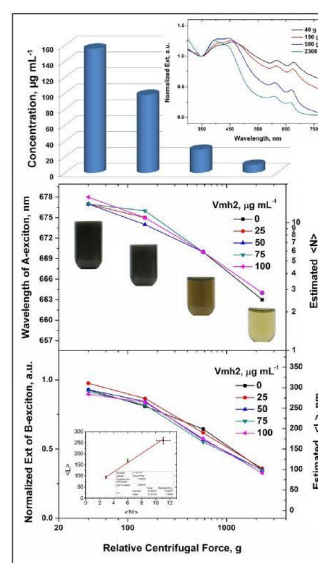


Figure 2 Extinction spectra of MoS₂ liquid dispersions