Characterization and transfer of mono- and few-layers exfoliated MoS_2 flakes onto optical fiber end-faces for saturable absorber applications

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Abstract: Several studies have been developed in the domain of nanomaterials, many of them with applications in photonic devices. Currently, it has been demonstrated that 2D materials, such as MoS_2 present short-pulse generation induced by notable nonlinear optical properties [1]. Recently, a technique for transferring exfoliated 2D materials has been successfully demonstrated by the transfer of exfoliated graphene onto optical fiber end-face [2]. In this technique, the mechanically exfoliated material can be removed from the original polymeric substrate (PMMA/PVA/glass stack) and be transferred and aligned onto another surface. In this work, we used the same technique for transferring exfoliated MoS_2 onto optical fiber end-face. Firstly, thin layers of water soluble polymer (polyvinyl alcohol, PVA, 1.2 µm thick) and polymethyl methacrylate (PMMA, 0.3 µm thick) are applied on glass substrate to form the stacked substrate. In sequence, mechanically exfoliated MoS2 flakes are deposited on this substrate, as schematically shown in Figure 1a. Optical image of an exfoliated MoS_2 sample is shown in Figure 1b. With Raman spectroscopy it is possible to characterize the MoS_2 flakes and identify the number of layers by the differences between E^1_{2g} and A_{1g} modes [3], as shown in Figure 1c. After the desired flake is characterized, the sample is immersed in water in order to remove the PVA layer and unstick the MoS_2/PMMA layer from the glass substrate. The standing PMMA layer, holding the exfoliated flake, can then be transferred to the future substrate. Figure 2a shows the mechanically exfoliated MoS_2 flake transferred to an optical fiber end-face and aligned to its core (illuminated area), and figure 2b shows a Raman mapping of the fiber core region, with the fiber core boundary depicted by the dashed line. These samples can be used for saturable absorber applications, enabling short-pulse generation in fiber laser systems.

References

[1] R. I. Woodward *et al.*, Photon. Res. 3, A30-A42 (2015)
[2] H. G. Rosa *et al.*,2D Materials 2, 031001 (2015).
[3] H. Li *et al.*, Adv. Funct. Mater. 22, 1385–1390 (2012).

Figures

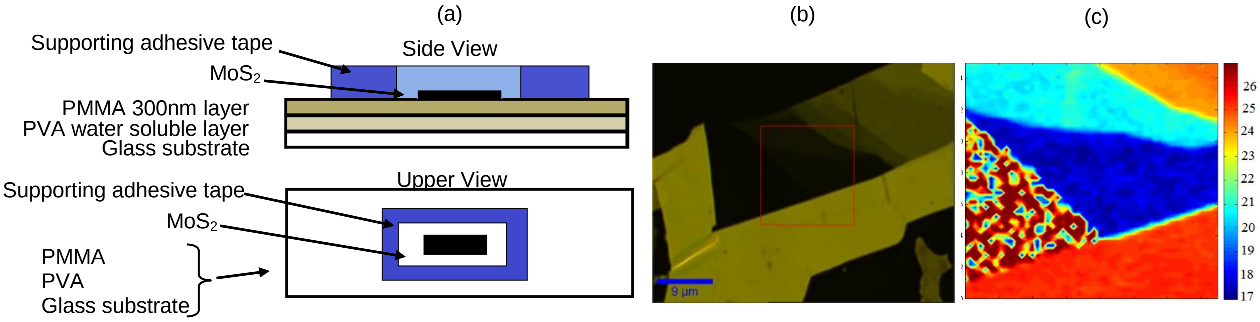

Figure 1: (a) PMMA/PVA/glass substrate diagram, (b) Image of a layer MoS2 flake over PMMA/PVA/glass substrate, and (c) Raman spectrum of the delimited surface in Figure 1b.

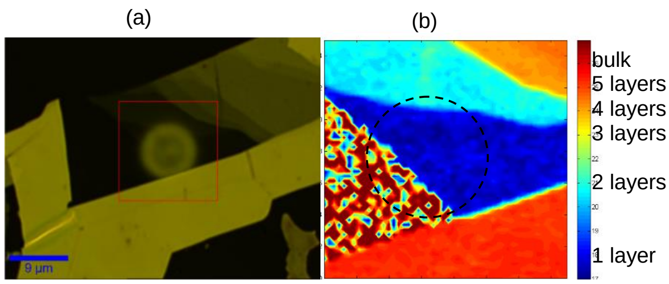

Figure 2: (a) Image of a layer MoS2 flake on the core of the illuminated fiber, and (b) Raman spectrum of the delimited surface in Figure 2a.