Photoluminescence enhancement in 1L-MoS_2 by thermal treatments

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Among 2D semiconductor materials, monolayer molybdenum disulfide (1L-MoS_2) is one of the most studied thanks to its physical properties that make it appealing for the develop of optoelectronic devices [1-3]. In particular both the nature and the size of its bandgap strongly depend on the number of layers composing such material. Going from bulk down to monolayer, the bandgap of MoS_2 changes from being indirect and equal to 1.2 eV to a wider 1.9 eV gap which allows for direct transitions leading to a strong photoluminescence due to excitonic recombination [4]. Furthermore, 1L-MoS_2 is also characterized by a high charge carrier mobility and good mechanical properties [5].

As other 2D materials, 1L-MoS_2 is very sensitive to interactions with the external environment. In this study we show how its properties, in particular its photoluminescence, can be influenced when exposed to different gases already at mild temperatures or due to the interaction with different substrates.

The photoluminescence of 1L-MoS_2 synthesized either *via* chemical vapor deposition or mechanical exfoliation on conducting, semiconducting and insulating substrates has been studied before and after thermal treatments conducted up to 225°C in different controlled atmospheres. Regardless of the nature of the substrate an enhancement of the photoluminescence intensity was observed, suggesting that the thermal treatments are able to partially reduce the defects occurring during the synthesis.

This study shows that is possible to improve the emission arising from the exciton recombination in 1L-MoS_2 with opportune post-synthesis thermal treatments, demonstrating how the properties of 1L- MoS_2 can be controlled towards the realization of optoelectronic devices.

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