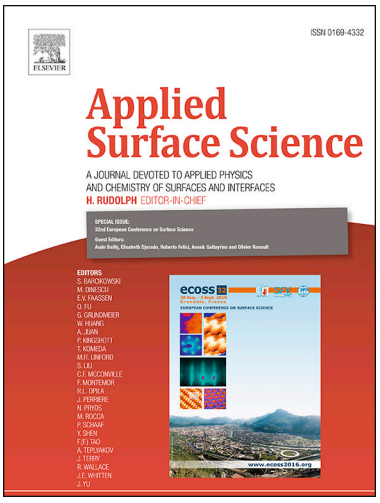
Accepted Manuscript



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PII: S0169-4332(18)30851-1
DOI: https://doi.org/10.1016/j.apsusc.2018.03.165
Reference: APSUSC 38913

To appear in: *Applied Surface Science*

Received Date: 4 March 2018
Accepted Date: 21 March 2018

Please cite this article as: S. Deb, P. Chakrabarti, P.K. Mohapatra, B.K. Barick, S. Dhar, Tailoring of defect luminescence in CVD grown monolayer MoS_2 film, *Applied Surface Science* (2018), doi: https://doi.org/10.1016/j.apsusc.2018.03.165

Tailoring of defect luminescence in CVD grown monolayer MoS_2 film

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Abstract

Optical properties of strictly monolayer MoS_2 films, which are grown on *c*-sapphire substrates using microcavity based CVD route, have been investigated by temperature dependent absorption and temperature as well as excitation intensity dependent photoluminescence (PL) spectroscopy. Our study reveals a high intensity broad luminescence band appearing at ∼1.7 eV along with the usual free exciton/trion peak (∼1.86 eV). The investigation furthermore attributes this broad transition to excitons bound to two types of defects, whose binding energies are found to be ∼11 and ∼118 meV. Integrated intensity of this feature decreases with the increase in the impinging sulfur flux during growth and by post-growth annealing in sulfur atmosphere suggesting that these defects must be related to sulfur deficiency. Interestingly, exciton-phonon coupling for these defect bound excitons is found to be much stronger than that is associated with free excitons/trions.

Keywords: CVD, Monolayer MoS_2, Raman Spectroscopy, Photoluminescence, Absorbance, Defect Luminescence

1. Introduction

Molybdenum disulfide, MoS_2 is a typical example of group VI transition metal dichalcogenide, consisting of S-Mo-S two dimensional (2D) layers which are coupled with each other by van der Waals forces. Weak nature of this inter layer coupling, makes it possible to separate single S-Mo-S sheets from bulk MoS_2. Unlike bulk MoS_2, which is an indirect band gap semiconductor, 1L-MoS_2 has a direct band gap of 1.9 eV[1, 2]. Moreover, in 1L-MoS_2, photoluminescence (PL) yield is approximately 10^4 times more than its bulk form[1]. All these make the material suitable for optoelectronic applications. In fact, 1L-MoS_2 based electroluminescent devices are already demonstrated[3].

Mechanical and chemical exfoliation methods to produce 1L-MoS_2 from its bulk form are the most widely used techniques as quality of the exfoliated layer can readily be ensured by proper choice of the parent material. But realizing large area coverage with strictly monolayer film is almost impossible through these methods. Owing to this difficulty, various other approaches have been

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