2DCC MIP at Penn State, DMR-1539916

External User Project - 2021

Bandgap recovery of monolayer MoS_2 using defect engineering and chemical doping

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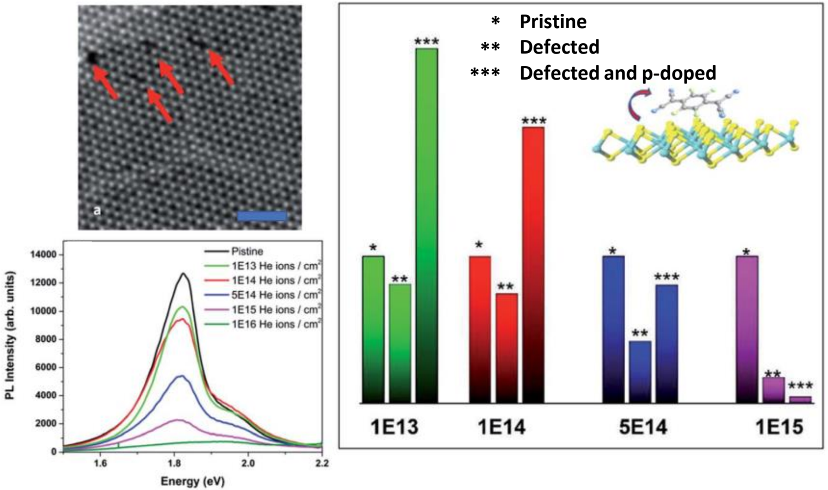
Project Summary: Two-dimensional transition metal dichalcogenides such as MoS_2 have created avenues for exciting physics with unique electronic and photonic applications. In this study, we report on the successful growth and modification of monolayer MoS_2 by controlling carrier concentration and manipulating bandgap in order to improve the efficiency of light emission. Monosulfur and disulfur vacancies were introduced into the MoS_2 using a Helium Ion Microscope. The carrier concentration in as-grown and irradiated samples was correlated with the 2D MoS_2 optical response. Reduced photoluminescence intensity in defected monolayers was restored and dramatically enhanced due to adsorption of p-type dopants (FATCNQ molecules) on the MoS_2 surface. The recovery of the optical response was attributed to a decrease in the excess electron concentration which resulted in an increase in the exciton oscillator strength. The results provide a pathway to improve the efficiency of light emission in devices based on two-dimensional materials. Published in: *RSC Adv.* 2021, 11, 20893.

2DCC Role: This paper resulted from a collaboration between two external users (S. Aravamudhan at NCA&T and T. Ignatova at UNC-Greensboro) who have been active participants in the 2DCC user committee and Graphene and Beyond for the past several years. Monolayer MoS_2 samples grown in the 2DCC facility were provided for this study.



A Helium Ion Microscope was used to introduce a controlled density of sulfur vacancies in monolayer MoS_2 which resulted in decreasing photoluminescence intensity. For lower defect concentrations, the introduction of a p-type dopant molecule (FATCNQ) enabled a recovery and significant enhancement of light emission.