Excitation-Dependent Raman Modes of Ion-Induced Defects in Monolayer $MoSe_2$

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Transition metal dichalcogenide (TMDC) monolayers, such as $MoSe_2$, have been extensively studied due to their unique physical properties. Intrinsic and induced defects can significantly influence their electronic and optical properties, impacting device performance and reliability. While defect studies are well-established for MoS_2 [1], research on defects in monolayers of $MoSe_2$ remains limited. Raman spectroscopy is a non-destructive and accessible technique for analyzing defects in 2D materials.
In this study, we induce point defects in a CVD-grown $MoSe_2$ monolayer via bombardment with singly charged argon ions with an energy of 600 eV. The ion fluences range from 10^{13} ions·cm^{-2} up to 10^{14} ions·cm^{-2}. The resulting defects are analyzed using Raman spectroscopy with three excitation energies, 2.71 eV, 2.33 eV and 1.95 eV. Additionally, cryogenic and room temperature measurements including Stokes and anti-Stokes modes were done. With increasing defect density, a shift in the A'_1 mode at 240 cm^{-1} becomes apparent. Defect-induced Raman modes were observed for all excitation energies in the range of 200 cm^{-1} to 350 cm^{-1} (Fig. 1). Furthermore, low-frequency modes emerge in the range from 100 cm^{-1} to 150 cm^{-1} under excitation at 2.33 eV and 1.95 eV excitation. Our results provide new insights into defect dynamics in $MoSe_2$ and highlight the power of multi-excitation Raman spectroscopy for probing point defects.

References

[1] Mignuzzi, S., et al., Phys. Rev. B, 91.19 (2015), 195411

Figures

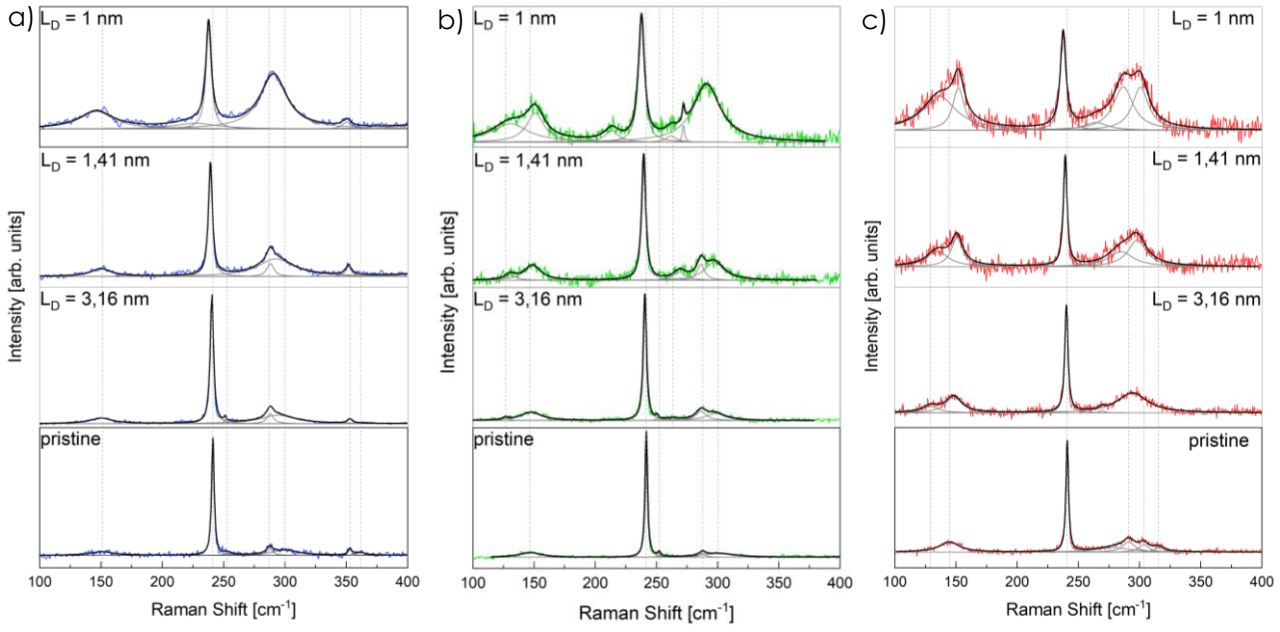

Figure 1: Raman spectra of $MoSe_2$ as a function of the inter-defect distance L_D. **a)** Spectra were obtained with 2.71 eV. **b)** Spectra were obtained with 2.33 eV. **c)** Spectra were obtained with 1.95 eV.