Investigation of Temperature-Dependent Raman Spectroscopy on Thin $PtSe_2$ Layers on Al_2O_3 Substrate

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The discovery of graphene and its physical properties began a new era in the investigation and application of layered materials [1,2]. These types of materials include also the Transition Metal Dichalcogenides (TMD). TMD materials provide a wide range of physical properties, such as the values of the charge carrier mobility and bandgap energy, which depend on the TMD layer thickness [3,4]. One of the most promising TMD materials from a technological point of view is platinum diselenide ($PtSe_2$) and for this reason, it is currently intensively investigated. Therefore, determining the impact of thermal processing on the properties of the $PtSe_2$ thin layer, including their chemical stability and layer-substrate interaction, is important. One of the powerful experimental methods for this characterization is temperature-dependent Raman spectroscopy. This technique allows for the estimation of the internal interactions by determining the impact of temperature on the intensity and positions of the characteristic vibrational modes for both the thin layer of $PtSe_2$ and the Al_2O_3 substrate.

In this presentation, the Raman spectroscopy results on samples with 1, 2, 3, 5, and 10 monolayers of $PtSe_2$ deposited on the Al_2O_3 substrate and the bulk $PtSe_2$ will be discussed. The considered temperature range is room temperature to 523 K. The analysis includes the temperature dependence of the band positions and their intensities for the vibration modes (E_g and A_{1g}) of both $PtSe_2$ and the substrate. The redshift effect of the Raman mode energy positions is observed as the temperature and thickness of the $PtSe_2$ layer also increase. Furthermore, a rapid increase in the intensity of Raman modes was observed for both the $PtSe_2$ layer and the Al_2O_3 substrate at a temperature of about 395 K, not observed for the bulk $PtSe_2$ sample. This observation seems to be an effect of the decrease in vibration damping due to the reduced interaction between the $PtSe_2$ layer and the Al_2O_3 substrate.

Acknowledgments: The study reported in this paper has been partially financed by the National Science Centre, grant No. 2019/35/O/ST5/01940

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