THz electrodynamics of transition metal dichalcogenides thin films

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Time domain THz spectroscopy (THz-TDS) is applied for extracting fruitful information on transition metal dichalcogenide (TMD) $MoSe_2$ and WSe_2 very thin films (d=20 nm) deposited on SiO_2 substrates through vapor phase sulfurization [1]. TMD materials are attracting a great deal of interest for applications in 2D- and opto-electronics [2]. THz-TDS is a coherent spectroscopic technique enabling to collect information on both the refractive index ($\tilde{n}$) and the conductivity ($\tilde{\sigma}$) of investigated films. The extraction procedure of $\tilde{n}$ from the transmitted e.m. signal is theoretically well defined in the case $\lambda\backslash d >>1$, where λ is the free space wavelength, in the opposite limit it still presents a series of relevant experimental and computational issues. State-of-the-art retrieval algorithms have been used to achieve $\tilde{n}$ and $\tilde{\sigma}$ of each films. The ensemble of electrodynamic information is widen by employing a Drude Smith fitting function, which allows to obtain intrinsic parameters of the material like the plasma frequency, the dc-conductivity and the average relaxation time (see fig. 1). The robustness of calculated electrodynamic parameters is further settled by comparing the retrieved data with ones achieved through mean field theories as Bruggeman, Landau−Lifshitz−Looyenga and Tinkham. Our results confirm that mean field theories can be employed to engineer new materials obtained by superposition of different thin films.

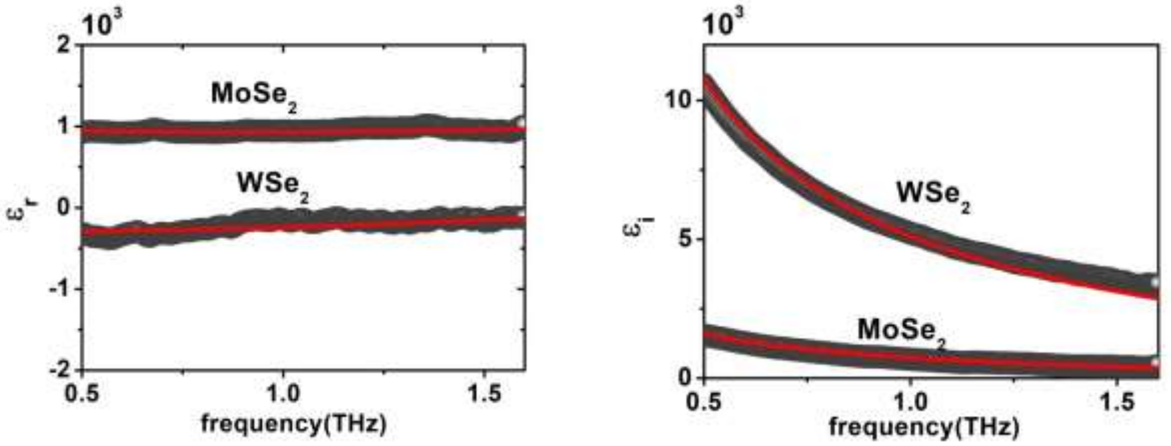

Figure 1: Real (left) and imaginary (right) parts of the dielectric function of measured WSe_2 and $MoSe_2$ thin films. Grey dotted lines represent the retrieved components whereas the red solid lines represent the fits obtained using the Drude-Smith function**.**

[1] R. Gatensby, T. Hallam, K. Lee, N. McEvoy, and G. S. Duesberg, "Investigations of vapour-phase deposited transition metal dichalcogenide films for future electronic applications," Solid. State. Electron., 125, 39–51 (2016).

[2] S. Manzeli, D. Ovchinnikov, D. Pasquier, O. V. Yazyev, and A. Kis, "2D transition metal dichalcogenides," Nat. Rev. Mater. **2,** 17033 (2017)