Neutral and Charged excitons in Tungsten Dichalcogenides Monolayer

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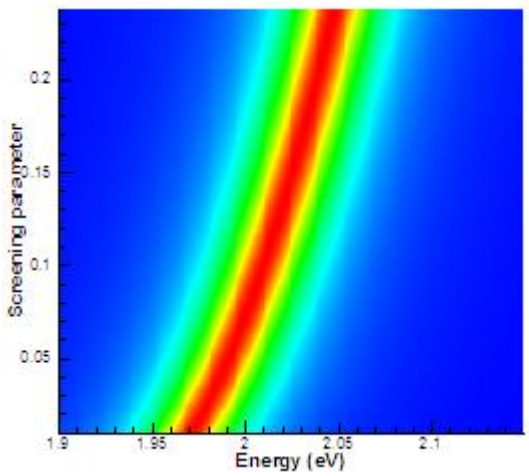
Abstract

Monolayer transition metal dichalcogenides (TMDs) have considered as semiconducting alternatives to graphene, for enriching many applications using two dimensional (2D) semiconductors. The principal features of TMDs are a strong Coulomb interaction between electron-hole caused by the relatively large carrier effective masses, reduced screening and carrier confinement. We show that the low binding energies of excitonic states deviate strongly from the standard 2D Wannier Mott model due to the correlations with the surrounding dielectric environment. Photo-excited electron hole pairs and doping induced charges to form trions which are bound states of two electrons with one hole. Using a non-local dielectric screening potential [1], exciton and trion energies calculated for monolayer WS_2, in particular, are shown to be in excellent agreement with photoluminescence measurements [2]. According to the mass action law we calculate the dependence of the intensity of neutral and charged exciton on doping and temperature. We show that the radiative lifetime of excitons increases linearly with temperature. Pump-and-probe measurements, clarify the experimental charge transfer mechanism, which is very efficient for exploiting the TMDs for optoelectronic applications.

References

[1] Stern, F. and Howard, W., Phys. Rev., **163** (1967) 816.
[2] A. A. Mitioglu, P. Plochocka, J. N. Jadczak, W. Escoffier, G. L. J. A. Rikken, L. Kulyuk, and D. K. Maude, Phys. Rev. B, **88** (2013) 245403.

Figure



Trion photoluminescence lineshape as a function of screening parameter.