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Tunable properties of excitons in double monolayer heterostructures

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Abstract

Nowadays, the so-called van der Waals heterostructures represent a prominent research area within optoelectronics in semiconductor 2D materials. The layered structures are related to the fact that they support the formation of excitons –bound electron-hole pairs –and excitonic complexes with binding energies more than an order of magnitude greater than conventional semiconductors, i.e. on the order of hundreds of meV, and small Bohr radii in the range of several nanometers [1-6]. In this work, we study the exciton properties of double layers of transition metal dichalcogenides (TMDs), where between the layers we have a dielectric spacer. We used an expansion of Chebyshev polynomials to solve the Wannier equation for the exciton. We systematically study both homo and hetero double layer systems for MX₂, showing the dependence of the inter and intralayer excitons binding energy as functions of the spacer width and dielectric constant. We also show how the exciton energy, that includes the effects of the changing band gap, depends on those geometric properties.

References

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