Energy transfer in mixed-dimension heterostructures base on super-radiant Dyes@BNNT and 2D semiconductors

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Since the discovery of graphene, the assembling of 2D semiconductors in van der Waals (VdW) heterostructures results in the emergence of fascinating properties [1] with potential applications in photonics and optoelectronics. However, the presence of intrinsic structural defects and inhomogeneities, associated to indirect band gaps in their bulk form, leads to non-radiative process and low fluorescence quantum yields. In contrast, OD materials such as luminescent organic molecules can act as quasi pure quantum emitters with strong light/matter interaction. However, these molecules are fragile and difficult to arrange and position at the nanoscale.

In this presentation we show that boron nitride nanotubes (BNNTs) can be used as a template for integrating a 1D chain of luminescent molecules [2-5] onto 2D semiconductors in the van der Waals regime. Different heterostructures are fabricated by either modifying the nature of the 2D material (MoS_2, WSe_2 ad WS_2), their thickness or the nature and spacing of the encapsulated molecules. We present methods for fabricating mixed-dimension heterostructures and fingerprints of optical interactions between molecules inside the BNNTs as well as between molecules and the 2D semiconductors in heterostructures, using polarized and time-resolved fluorescence imaging and spectroscopy.

References

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