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Excitons in mixed-dimensional heterostructures

From the isolation of graphene in 2004, many types of two-dimensional (2D) layered materials have been discovered. The van der Waals nature allows to integrate 2D materials with other materials such as one-dimensional carbon nanotubes (CNTs), forming a mixed-dimensional heterostructure. The Coulomb interactions are enhanced in these low-dimensional materials because of the limited screening effect, resulting in stable exciton formation even at room temperature [1]. Versatile excitonic phenomena are expected in the mixed-dimensional heterostructures, since optical properties of 2D materials change largely with layer number and types.

Here we first demonstrate that hexagonal boron nitride (h-BN), a widely studied 2D insulator, is an ideal substrate for CNTs [2]. By performing PL spectroscopy on heterostructures, we observe that CNTs directly attached to h-BN are highly luminescent with linewidths of ~12 meV. The benefit of h-BN is indicated when coupling a CNT to a photonic crystal microcavity. With an h-BN nano-spacer to prevent exciton quenching, we observe a cavity-coupled narrow line above a PL spectrum of the CNT [3]. We then find that 2D materials tune the cavity mode effectively with a proper cavity design. The clearly resolved steps between the resonant wavelengths suggest the mode shifts are quantized due to the discrete thickness of atomically thin layers. We will also discuss very recent results on tungsten diselenide/CNT heterostructures.

参考文献

[1] A. Ishii, M. Yoshida, Y. K. Kato, Phys. Rev. B **91**, 125427 (2015).
[2] N. Fang, K. Otsuka, A. Ishii, T. Taniguchi, K. Watanabe, K. Nagashio, Y. K. Kato, ACS Photonics 7, 1773 (2020).
[3] K. Otsuka, N. Fang, D. Yamashita, T. Taniguchi, K. Watanabe, Y. K. Kato, Nat. Commun. 12, 3138 (2021).