
Plasmonic Nanocavity Induced Room-temperature Emissions of 2D Dark Excitons and Charged Biexcitons

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In this talk, I will demonstrate how to employ plasmon-exciton coupling spectroscopy to determine the relative energies of bright and dark excitons in monolayer MoS₂ and WS₂ by examining their respective temperature-dependent bright-exciton coupling strength with localized surface plasmons [ACS Photonics 2019, 6(11), 411-421]. Following this, I will illustrate that the temperature dependence of the WS₂ A-exciton emission energy can be well described with the Varshni formula and its temperature dependent emission intensity is associated with the population redistribution of bright and dark excitons at elevated temperatures [Nanoscale Horizons 2019, 4(4), 969-974]. I will then show that coupling monolayer WS₂ with a plasmonic nanocavity of an extreme structural asymmetry and ultrasmall mode volume results in plasmon-induced resonant emission of spin-forbidden dark excitons with signal intensity comparable to that of spin-allowed bright excitons [Nano Letters 2022, 22(5), 1915-1921]. This is distinctive from conventional large-mode-volume plasmonic cavities that can only enhance spin-allowed electronic transitions in quantum emitters [Nanophotonics 2020, 9(7), 2097-2015]. Finally, I will report strong room-temperature emission of charged biexcitons from a gold nanosphere capped WS₂ monolayer through localized surface plasmon induced hot-electron injection [Physical Review Materials 2023, 7, 054002], and demonstrate all-optical control of the emission intensity through on- or off-resonant LSP excitation.



Short Bio:

Dangyuan LEI received his PhD degree in Physics from Imperial College London, UK. He is Professor of Materials Science and Engineering at The City University of Hong Kong, China, and Provost's Visiting Professor of Physics at Imperial College London. His research interest centers on nanophotonics and low-

dimensional quantum materials, with particular interest in the nanoscale cavity-matter interaction.