Tunable Resonance Coupling in a 1D Plasmonic-Exciton Hybrid Systems

(D)Min-Wen Yu[1,2], Satoshi Ishii[2], Shisheng Li[2], Ji-Ren Ku[3], Jhen-Hong Yang[4], Kuan-Lin Su[1],

Takaaki Taniguchi[2], Tadaaki Nagao[2], Kuo-Ping Chen[3]

[1]Institute of Lighting and Energy Photonics, College of Photonics, National Chiao Tung University, 301 Gaofa 3rd Road, Tainan 711, Taiwan

[2]International Center for Materials Nanoarchitectonics (MANA), National Institute for Materials Science (NIMS), 1-1 Namiki, Tsukuba, Ibaraki 305-0044, Japan

[3]Institute of Imaging and Biomedical Photonics, College of Photonics, National Chiao Tung University, 301 Gaofa 3rd Road, Tainan 711, Taiwan

[4]Institute of Photonic System, College of Photonics, National Chiao Tung University, 301 Gaofa 3rd Road, Tainan 711, Taiwan

E-mail: sishii@nims.go.jp; NAGAO.Tadaaki@nims.go.jp; kpchen@nctu.edu.tw

Abstract

Atomic layers of transition metal dichalcogenides (TMDCs) have recently gained numerous attentions owing to their exciting optical and electronic properties [1]. Monolayer, molybdenum and tungsten based TMDCs become direct band gap semiconductor, with strong binding energies which make them as perfect candidates for light-matter coupling system. We demonstrate strong coupling in plasmonic-exciton hybrid systems by incorporating monolayer of molybdenum disulfide MoS_2 [2] onto 1D Au nanogrooves arrays which can provide giant photoluminescence (PL) enhancement when the surface plasmon resonance matches to the MoS_2 exciton as shown in Fig 1. The strong coupling has also been confirmed by Kelvin probe force microscope (KPFM) and Rabi splitting estimation. Our attempts pave the way to an exciting field of nanophotonic, optoelectronic, and quantum optical devices based on plasmonic-exciton coupling at a room temperature.

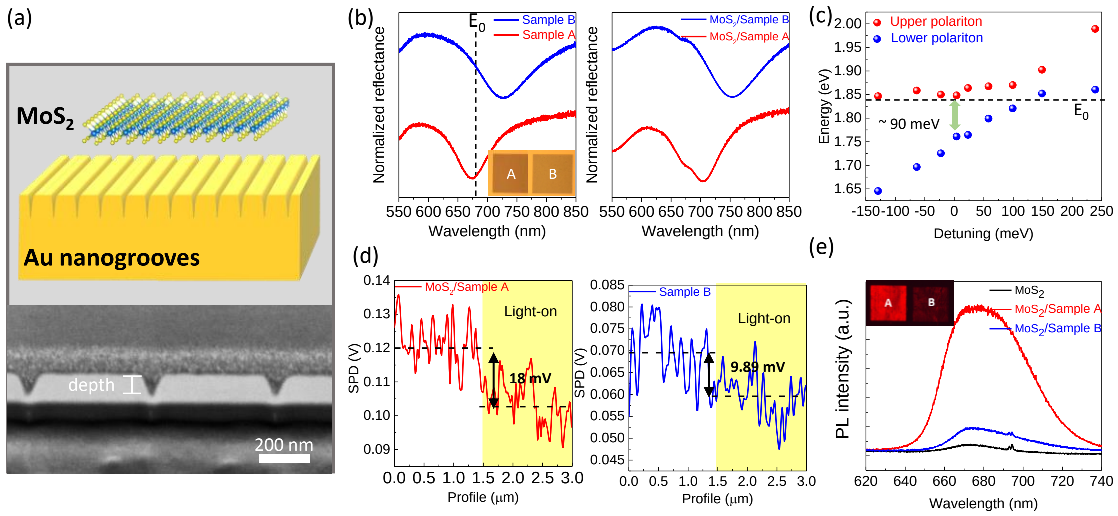

Fig 1. (a) Schematic of plasmonic-exciton hybrid systems. (b) Normalized reflectance spectra of samples A and B before (left) and after (right) MoS_2 transfer. The dashed line labeled as E_0 shows the position of MoS_2 exciton. The insets are optical images of MoS_2/sample A, B. (c) Dispersion of plasmon-exciton coupling of the upper polariton and lower polariton varied as a function of detuning. The blue and red dots are experimental data extracted from the reflectance spectra. The Rabi-splitting energy was estimated about 90 meV. (d) Surface potential difference (SPD) of sample A (left) and Sample B (right). The 532 nm laser was tuned on at the marked region. These data are performed by KPFM. (e) PL measurement of MoS_2/Sample A, B and MoS_2 on gold film without pattern. The insets are PL images of MoS_2/sample A, B which were taken by fluorescence microscope.

Reference

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[2] Li, Shisheng, *et al.* Nanoscale, 11, 16122-16129 (2019).