Enhanced valley polarization and extended valley lifetime of monolayer MoS_2 in a chiral plasmon-valley exciton coupling system

Jiahe Liu[1,2], Feihong Liu[1], Tingyang Xing[1], Yifan Wang[1], Zhiwei Peng[1], Liang Guo[2], Wang Yao[3,4] and Dangyuan Lei[1,5,*]

[1]*Department of Materials Science and Engineering, City University of Hong Kong, Hong Kong S.A.R., 999077, China*

[2]*Department of Mechanical and Energy Engineering, Southern University of Science and Technology, Shenzhen, 518055, China*

[3]*New Cornerstone Science Laboratory, Department of Physics, The University of Hong Kong, Hong Kong S.A.R., 999077, China*

[4]*HK Institute of Quantum Science & Technology, The University of Hong Kong, Hong Kong S.A.R., 999077, China*

[5]*Department of Physics, Centre for Functional Photonics, Hong Kong Branch of National Precious Metals Material Engineering Research Centre, and Hong Kong Institute of Clean Energy, City University of Hong Kong, Hong Kong S.A.R., 999077, China*

Email: dangylei@cityu.edu.hk

The broken inversion symmetry in monolayer transition metal dichalcogenides (TMDs) permits light of specific helicity to address valley-polarized excitonic states, which could serve as inherent information carriers[1]. However, achieving high valley contrast at room temperature is challenging due to strong intervalley interactions. To tackle this, we coupled a single chiral plasmonic nano-resonator with a MoS_2 monolayer to prolong the latter's valley polarization through chiral plasmon-valley exciton selective coupling[2]. Our time-integrated and transient spectroscopic measurements show that the selective coupling enhances the room-temperature photoluminescence (PL) degree of circular polarization (DCP) from 4.1% to 41.8%, originating from significantly prolonged valley exciton density contrast lifetime in the coupled MoS_2 from less than 1 ps to over 120 ps. The experimental results are further corroborated by a full quantum model, which reveals distinct coupling strengths for the K and K′ valleys and a strong correlation between plasmon-exciton energy detuning and the PL DCP. Our findings offer new possibilities for information encoding and storage by exploiting the valley degree of freedom in cavity-coupled low-dimensional semiconductors[3].

References

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