Abstract to be submitted to the AVS 66th International Symposium and Exhibition
October 20- 25, 2019
Columbus, OH

Indirect transition and opposite circular polarization of Interlayer Exciton in a $MoSe_2/WSe_2$ van der Waals Heterostructure

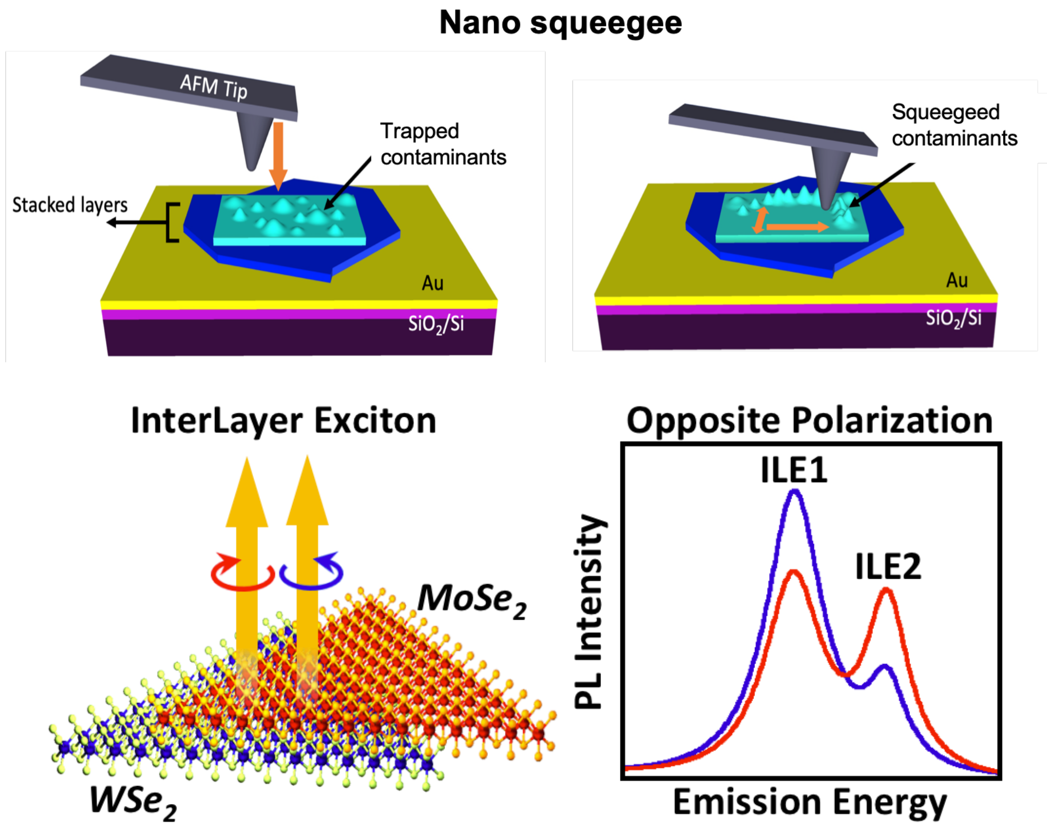
Hsun-Jen Chuang[a], A.T. Hanbicki, M.R. Rosenberger[b], C. Stephen Hellberg, S.V. Sivaram[b], K.M. McCreary, I.I. Mazin, and B.T. Jonker
Naval Research Laboratory, Washington, DC 20375

[a] Postdoctoral associate at the Naval Research Laboratory through the American Society for Engineering Education

[b] Postdoctoral associate at the Naval Research Laboratory through the National Research Council

An emerging class of heterostructures involves monolayer semiconductors such as many of the transition metal dichalcogenides (TMDs) which can be combined to form van der Waals heterostructures (vdWHs). One unique new optical property of heterostructure is an interlayer exciton (ILE), a spatially indirect, electron-hole pair with the electron in one TMD layer and the hole in the other. Here, we fabricated MoSe2/WSe2 hetero-bilayer encapsulated in h-BN with the alignment angle close to 60 degree between MoSe2 and WSe2. Followed by the state-of-the-art preparation techniques (Nano-squeegee) to ensure the optimal contact between the TMDs. The Strong ILE emission is observed with the emission around 1.35 eV at room temperature and resolve this emission into two distinct peaks (ILE1 and ILE2) separated by 24 meV at zero field at 5 K. Furthermore, we demonstrate that the two emission peaks have *opposite* circular polarizations with up to +20% for the ILE1 and -40% for ILE2 when excited by circularly polarized light. A*b initio* calculations provide an explanation of this unique and potentially useful property and indicate that it is a result of the indirect character of *both* electronic transitions. These peaks are *double indirect* excitons. *i.e*. indirect in both real and reciprocal space, split by relativistic effects.

This research was performed while H.-J.C. held an American Society for Engineering Education fellowship and M.R.R and S.V.S held a National Research Council fellowship at NRL. This work was supported by core programs at NRL and the NRL Nanoscience Institute. This work was also supported in part by a grant of computer time from the DoD High Performance Computing Modernization Program at the U.S. Army Research Laboratory Supercomputing Resource Center.


Nano squeegee
AFM Tip
Trapped contaminants
Stacked layers
Au
SiO_2/Si
Squeegeed contaminants
Au
SiO_2/Si
InterLayer Exciton
$MoSe_2$
WSe_2
Opposite Polarization
ILE1
ILE2
PL Intensity
Emission Energy