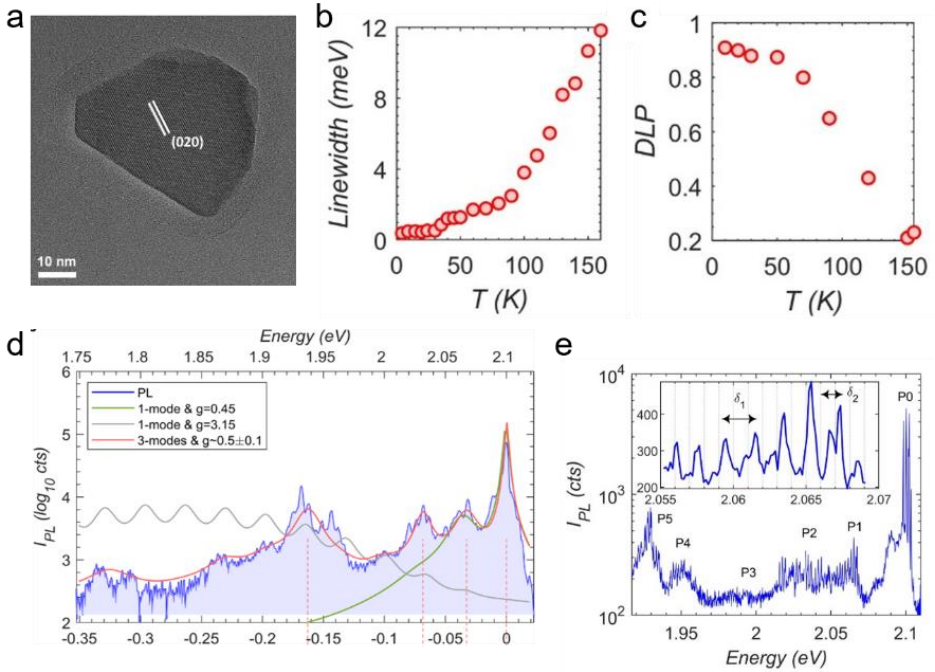
Correlated Excitons in a Nanoscale 2D-Antiferromagnet

Scientific Achievement

Individual nano-flakes of NiPS3 2D-antiferromagnet displays signatures of correlated excitons arising from entangled charge, spin, orbital, and lattice degrees of freedom.



(a) TEM image of NiPS3 nano-flake. (b-c) Trend of linewidth and degree of linear polarization with temperature reflects the Néel transition behavior. (d) Multiple phonon replica. (e) Comb-like spectra.

Significance and Impact

Lateral size can be utilized to control the emission characteristics towards integrated magneto-optic devices.

Research Details

- Crystalline nano-flakes of NiPS3 are chemically synthesized using metathesis reaction and the photoluminescence showed spin-correlated excitons reflecting Néel transition.
- Cryogenic study revealed ultra-sharp spectral peaks indicative of highly coherent emission, multiple phonon replicas from strong exciton phonon coupling, and a comb-like spectra from discretized charge fluctuations in 2D-antiferromagnet layers.

This work was performed in part at The Center for Integrated Nanotechnologies.

Chandrasekaran, V.; DeLaney, C. R.; Trinh, C. T.; Parobek, D.; Lane, C. A.; Zhu, J.-X.; Li, X.; Zhao, H.; Campbell, M. A.; Martin, L.; Wyckoff, E. F.; Jones, A. C.; Schneider, M. M.; Watt, J.; Pettes, M. T.; Ivanov, S. A.; Piryatinski, A.; Dunlap, D. H.; Htoon, H. Correlated Excitonic Signatures of Individual van Der Waals Nips3 Antiferromagnet Nanoflakes. *Nanoscale Horizons* 2024.