

Prolonged Dephasing Time of Ensemble of Moiré-Trapped Interlayer Excitons in a WSe₂-MoSe₂ Heterobilayer

Supplementary Data

Mehmet Atıf Durmuş¹, Kaan Demiralay¹, Muhammad Mansoor Khan¹ and Ibrahim Sarpkaya*¹

¹ Bilkent University UNAM – National Nanotechnology Research Center, Ankara 06800, Turkey

*Corresponding author. Email: sarpkaya@unam.bilkent.edu.tr

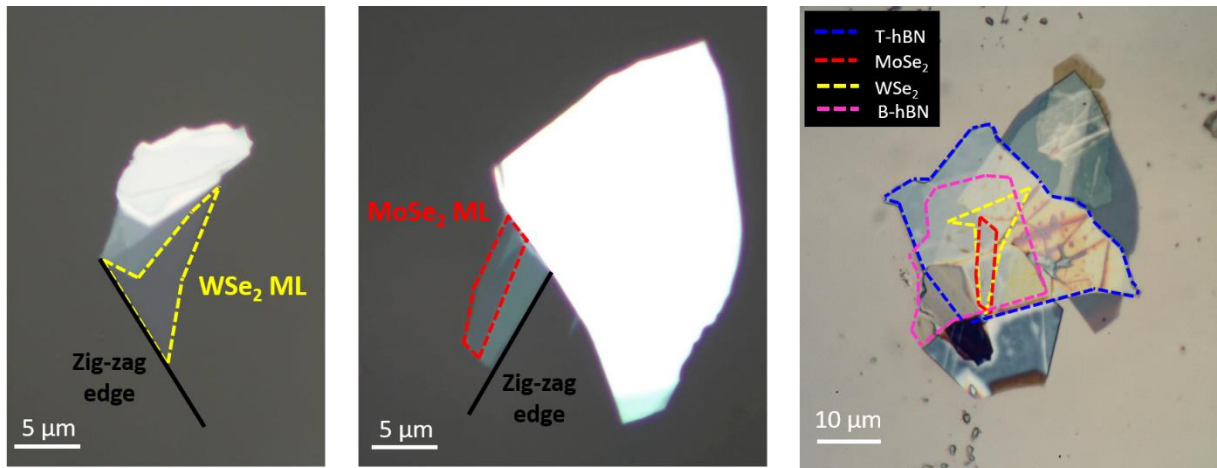


Figure S1: Optical microscope images of the WSe₂ and MoSe₂ flakes before stacking and after their heterobilayer (HS6) fabrication. Yellow and red dashed lines show the monolayer parts of the flakes. Black lines indicate the defined zig-zag edges according to the edge identification method¹.

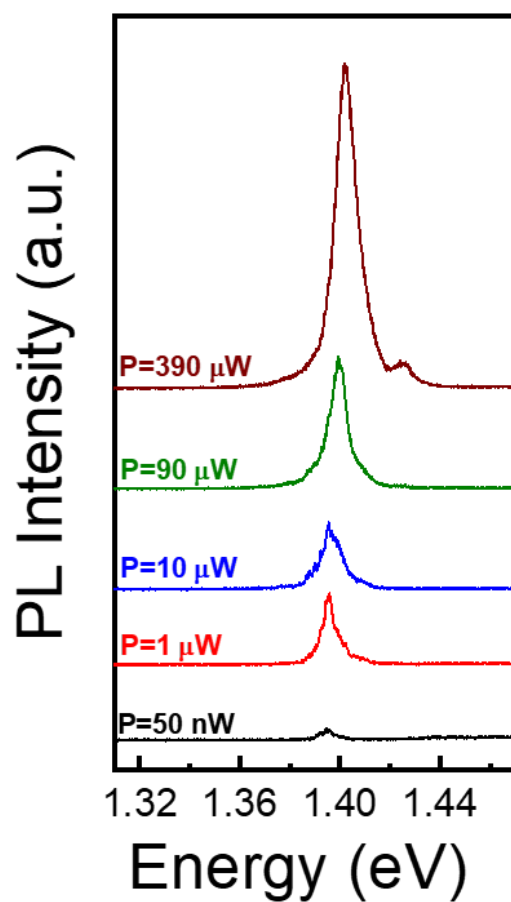


Figure S2: Low-temperature PL spectra of IX emission under different excitation powers. For the high pump power ($P=390\mu\text{W}$) PL spectrum, the high energy spin-singlet emission can also be seen clearly with the energy separation of approximately 25 meV from spin-triplet emission. Data are recorded at 3.5K.

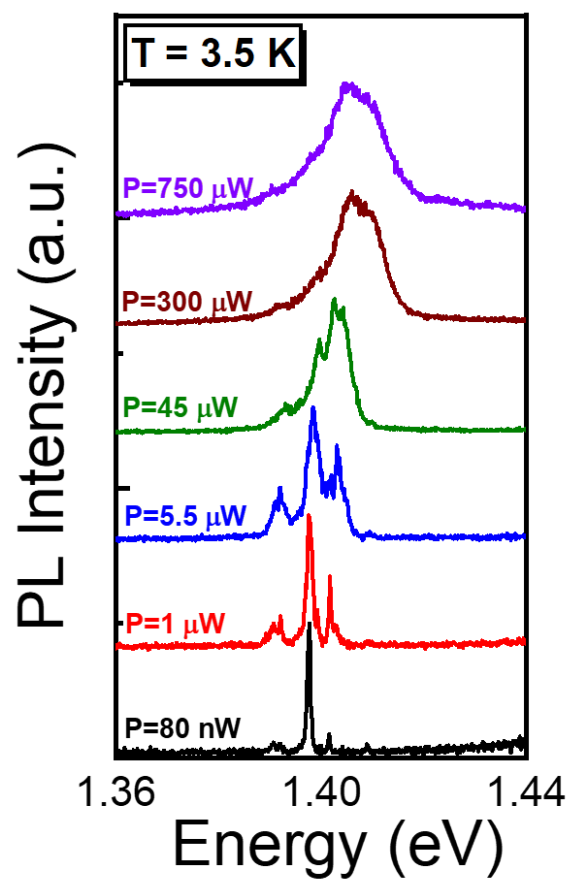


Figure S3: Low-temperature PL spectra of moiré-trapped IX emission (HS5) under different excitation powers. Data are recorded at 3.5K.

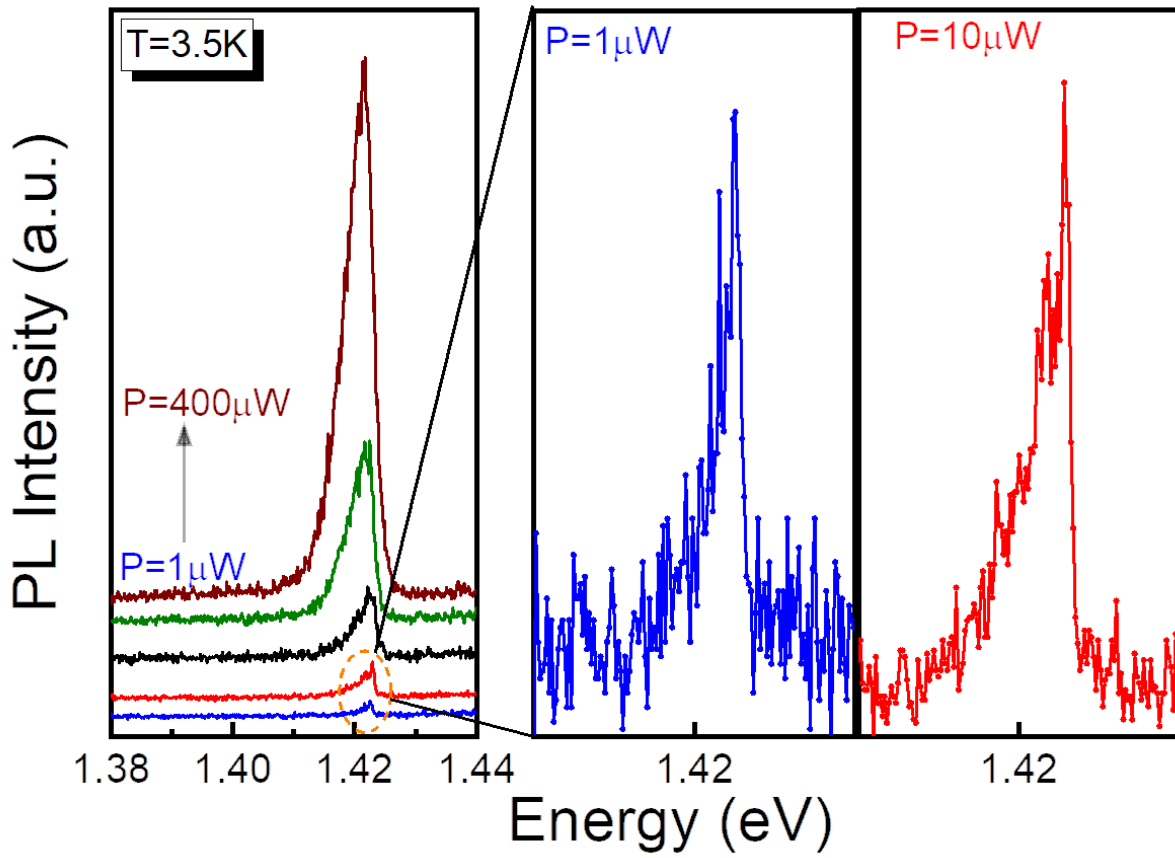


Figure S4: Low-temperature PL spectra of another moiré-trapped IX emission (HS6) under different excitation powers. Sharp and narrow emission lines have been observed in the low pump power regime. The right-hand side figures show the zoomed-in version of the two PL spectra taken under low pump power. Data are recorded at 3.5K.

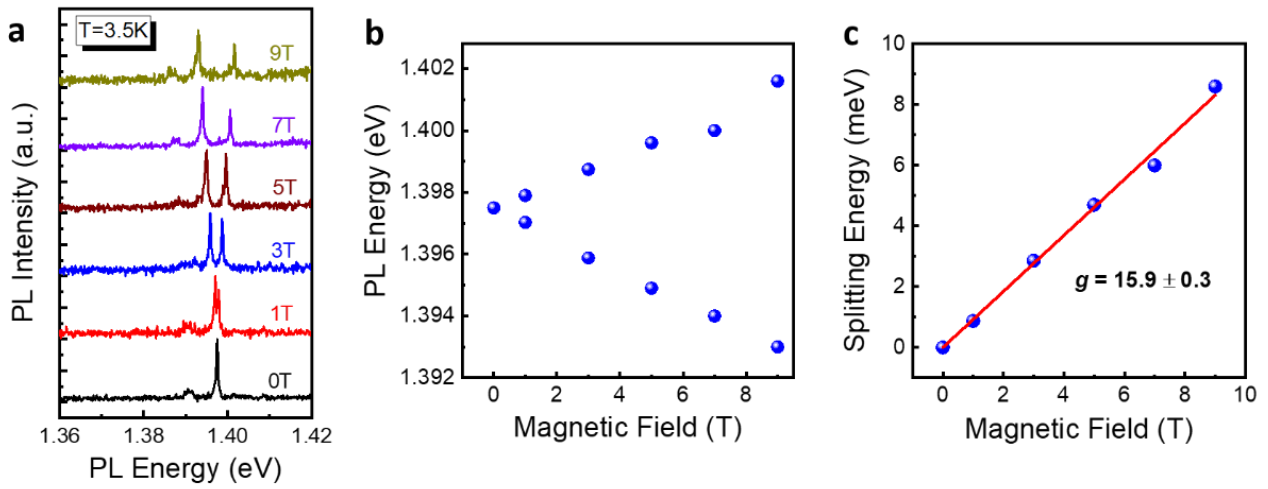


Figure S5: Zeeman splitting of moiré-trapped IX emission in the WSe₂/MoSe₂ heterobilayer sample. **a)** The PL spectra of the moiré-trapped IX as a function of the strength of an applied out-of-plane magnetic field under 532 nm CW laser excitation. **b)** The PL peak energies as a function of the applied magnetic field. **c)** The Zeeman splitting measured for the moiré-trapped IX with an effective g factor of 15.9 ± 0.3 . Data are recorded at 3.5K.

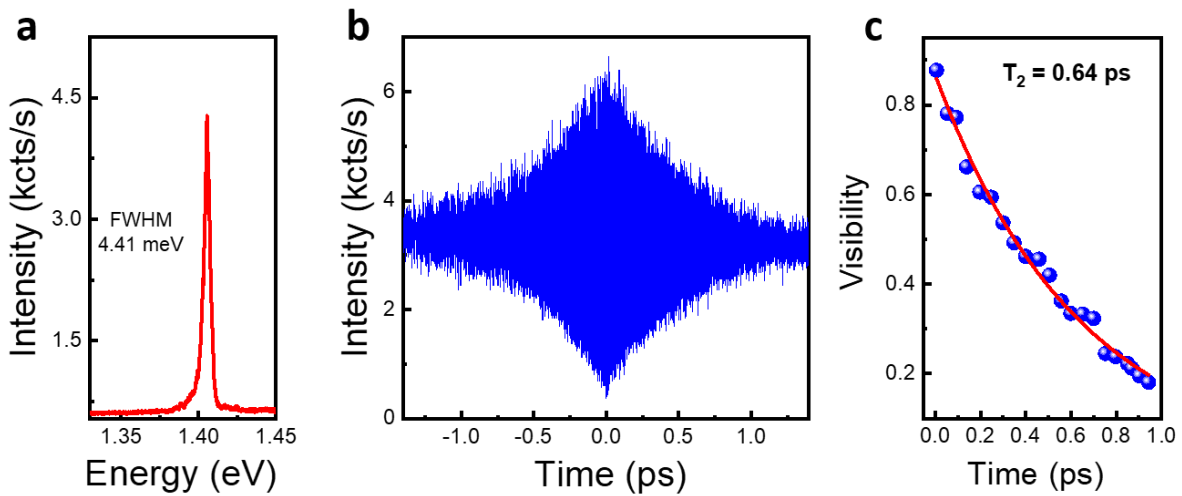


Figure S6: IX dephasing time measurements using a home-built Michelson Interferometer. **a)** The PL spectrum of the ensemble of moiré interlayer excitons under 532-nm CW laser excitation with a power of 50 μW . **b)** Interferogram of the first order coherence function $g^{(1)}(\tau)$ of the moiré-trapped IX. **c)** The fringe visibility as a function of delay time for the ensemble of moiré localized IX emission of the WSe₂/MoSe₂ heterobilayer (HS 5). It shows a mono-exponential decay, and the red line indicates the fit that gives a value of $T_2 = 0.64 \text{ ps}$.

References

1. Guo, Y. *et al.* Distinctive in-Plane Cleavage Behaviors of Two-Dimensional Layered Materials. *ACS Nano* **10**, 8980–8988 (2016).