Electronic Supplementary Material (ESI) for Nanoscale.

Supplementary Information

Twist-angle-controlled neutral exciton annihilation in WS_2 homostructures

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Supplementary Figures: S1, S2, S3, S4, S5, S6, and S7

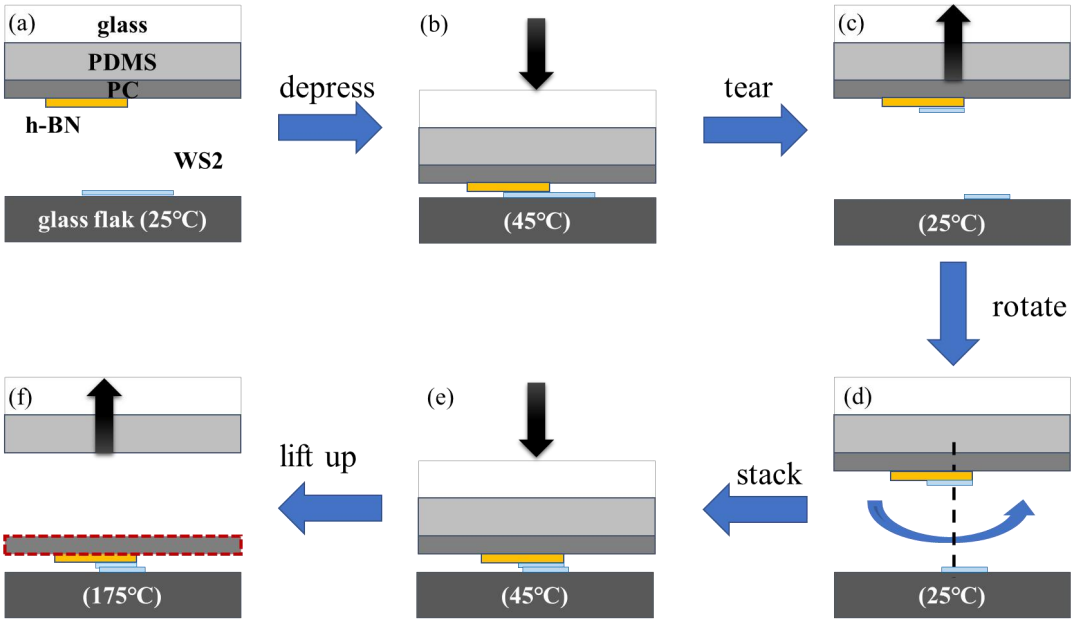

Fig. S1 Schematic diagram of the process of preparing twisted WS_2 homostructures. Different colors are used to distinguish different materials. (a) Stack glass, PDMS, and PC, in turn, to pick up thin layers of h-BN at 25°C. (b) Release the stack, The h-BN comes into slow contact with a part of the monolayer WS_2 at 45°C. (c) Slowly lift the stack at 25°C. (d) Rotate and translate the stack to align the monolayer WS_2 remaining on the glass flake. The adjustment accuracy of our instrument is about 0.1°. (e) Release the stack, the two pieces of the monolayer WS_2 are in slow contact at 45°C. (f) Slowly lift the upper stack at 175 °C. Due to the melting of PC at the high temperature, PC and the target stack under PC remain on the glass flake. Finally, rinse with chloroform for ten minutes to remove PC, the twisted WS_2 homostructures of h-BN encapsulation are obtained. In particular, the temperature value is only for reference, and the specific working temperature depends on the actual situation.

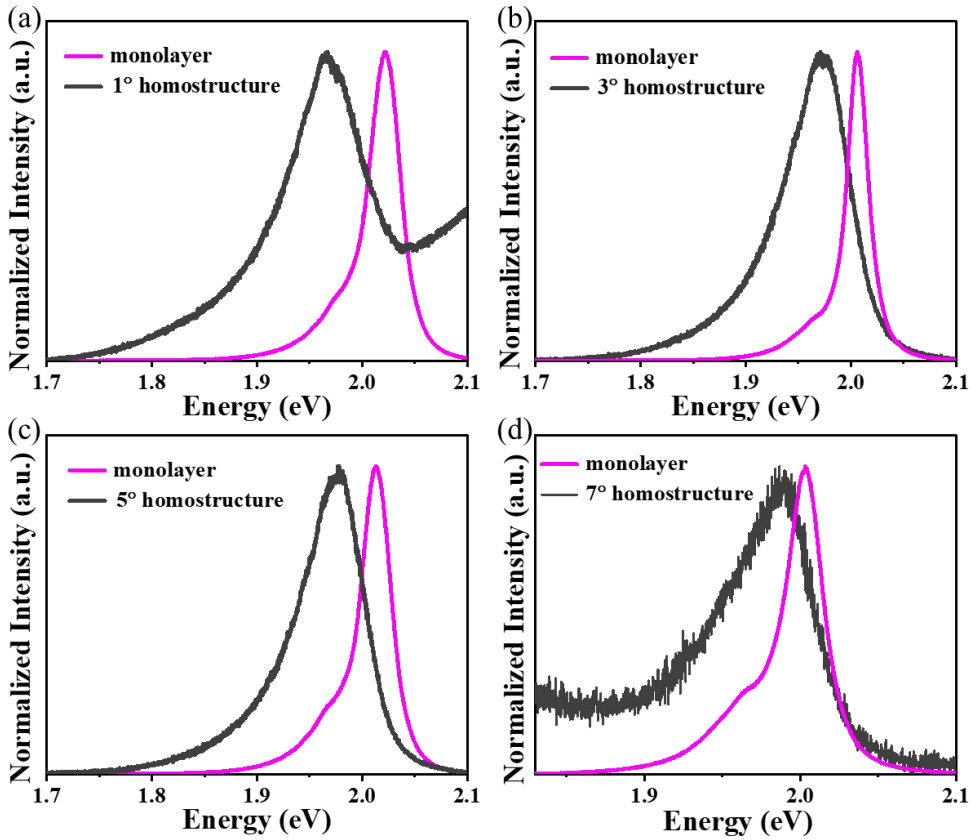

Fig. S2 The normalized PL spectrum of samples with different interlayer twist angles. (a) The normalized PL spectrum of 1° homostructure. (b) The normalized PL spectrum of 3° homostructure. (c) The normalized PL spectrum of 5° homostructure. (d) The normalized PL spectrum of 7° homostructure.

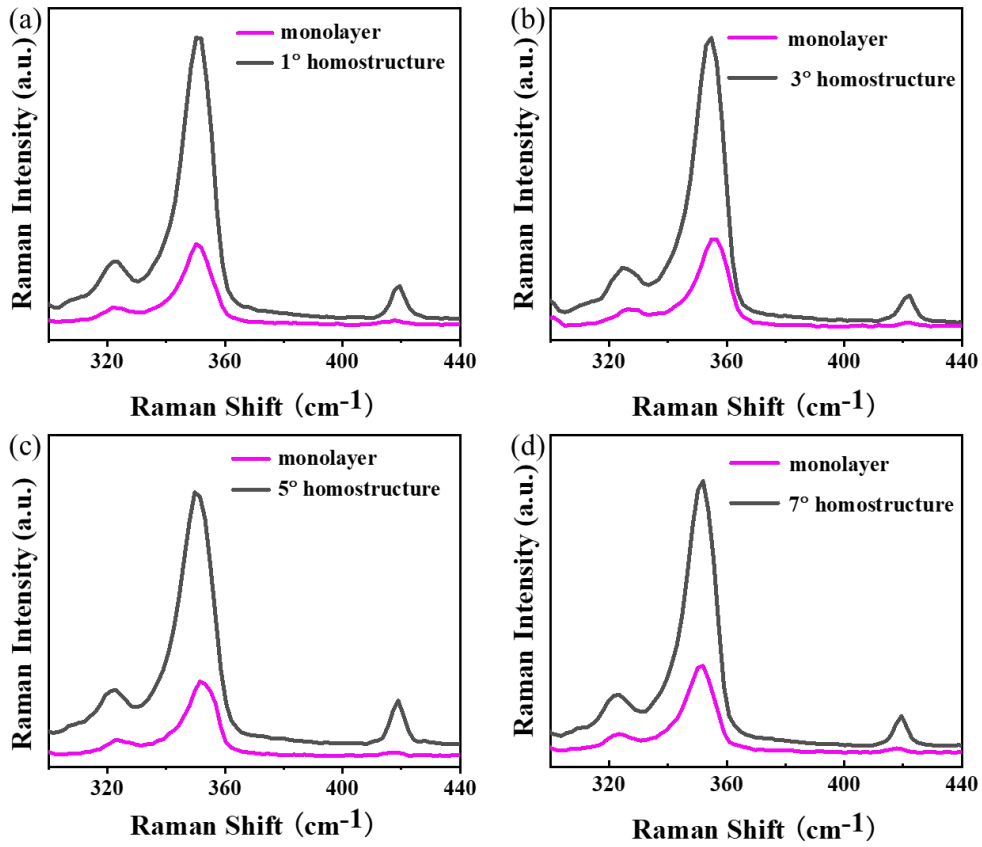

Fig. S3 The Raman spectrum of samples with different interlayer twist angles. (a) The Raman spectrum of 1° homostructure. (b) The Raman spectrum of 3° homostructure. (c) The Raman spectrum of 5° homostructure. (d) The Raman spectrum of 7° homostructure.

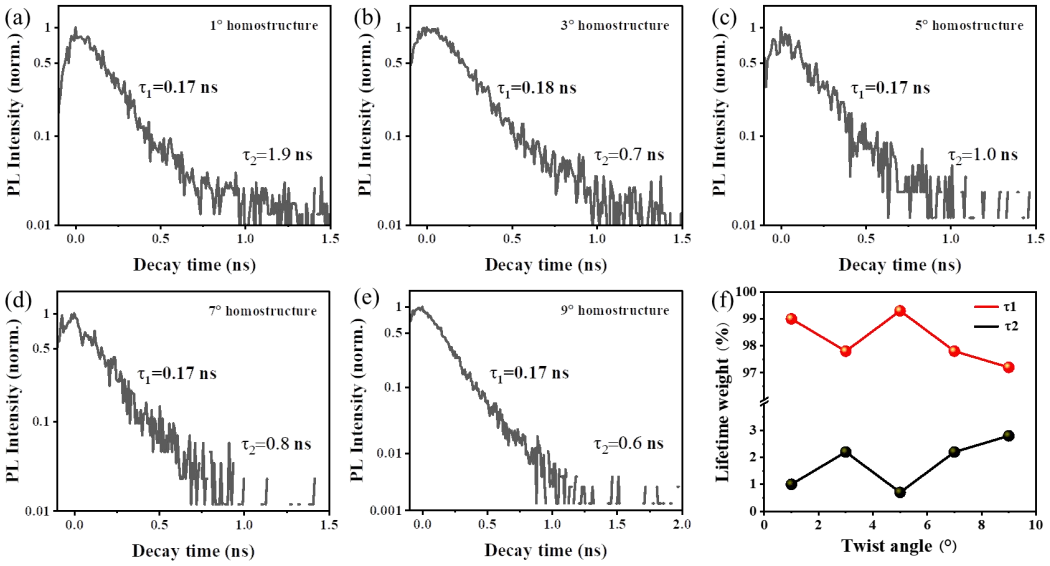

Fig. S4 The TRPL dynamics of samples with different twist angles at a low excitation intensity of 68 μW. (a) The TRPL decay curve of 1° homostructure. (b) The TRPL decay curve of 3° homostructure. (c) The TRPL decay curve of 5° homostructure. (d) The TRPL decay curve of 7° homostructure. (e) The TRPL decay curve of 9° homostructure. (f) Lifetime weight of the short lifetime component and the long lifetime component as a function of pulse excitation power.

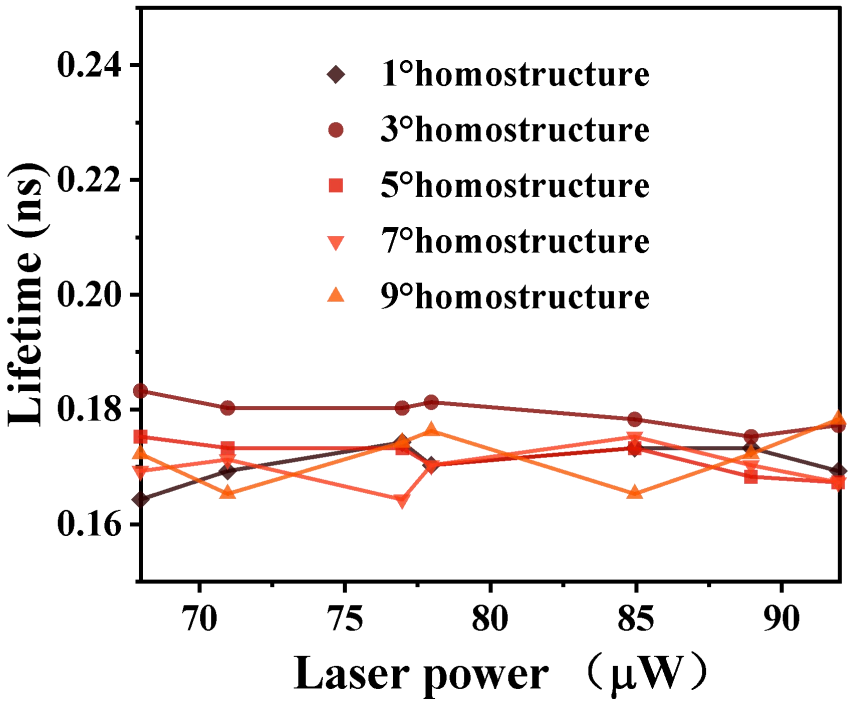

Fig. S5 The lifetime of neutral exciton of WS_2 homostructures with different twist angles in the excitation power range of 68 μW to 92 μW.

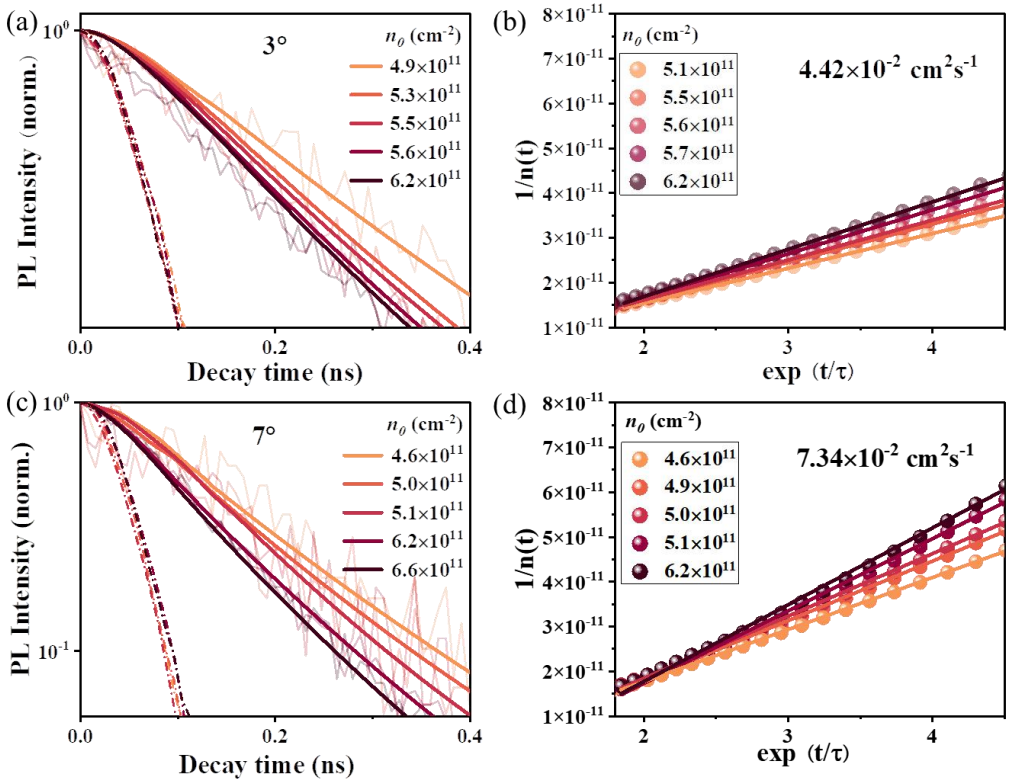

Fig. S6 EEA rates of neutral exciton in 3° and 7° homostructures. (a, c) Time-resolved PL (TRPL) decay curves of 3°and 7° WS_2 homostructures at various excitation intensities. The dotted lines are the IRF curves corresponding to the TRPL curves. (b, d) Linearization data of TRPL curves of neutral exciton in (a, c) using Equation (4).

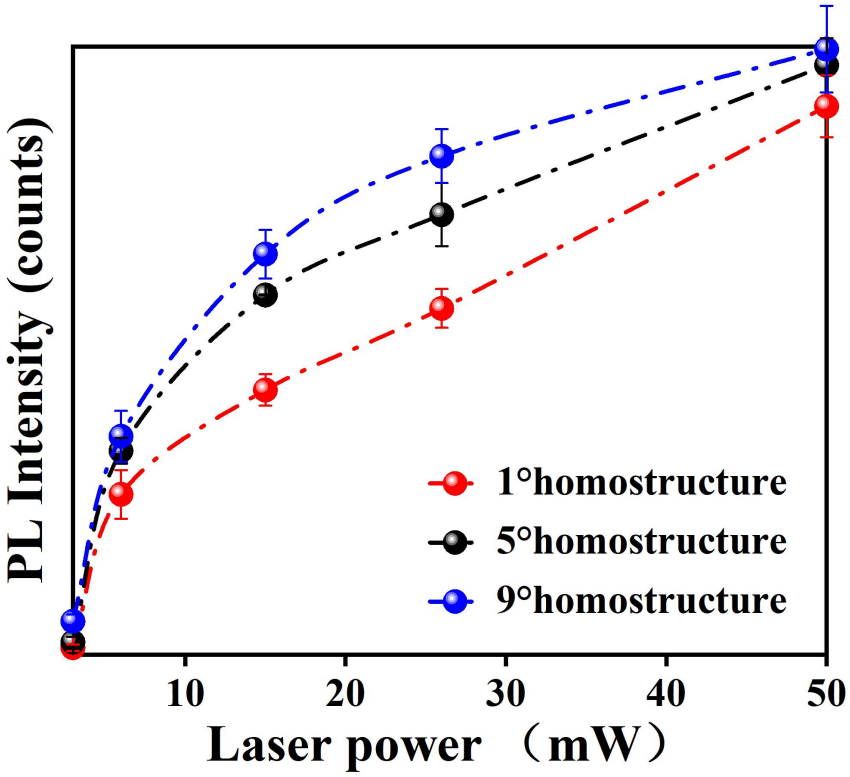

Fig. S7 Dependence of steady PL intensity of neutral excitons on the laser power in 1°, 5°, and 9° WS_2 homostructure.