WS_2-LED electroluminescence enhancement by TFSI treatment

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Light-emitting diodes (LEDs) based on layered materials heterostructures (LMHs) exploit the direct bandgap of semiconducting mono-layer transition metal dichalcogenides (1L-TMDs)[1-3]. Crucial for their performance is the electroluminescence external quantum efficiency (EL-EQE), i.e. the ratio between emitted photons and injected electrons. LEDs based on LMHs have been reported with EL-EQE from ~10^{-4}% to ~4%[4-8], depending basically TMD and temperature of operation[4-8]. Different approaches[8], including chemicals treatments such as superacid bis-(triuoromethane)sulfonimide (TFSI)[9-12] were suggested to enhance the 1L-TMDs PL emission. Here, we fabricate TMD-LEDs via vertically-stacking single-layer graphene (SLG), used as electrode for charge injection, few-layers hBN as tunnel barrier, and 1L-WS_2 for light emission. We demonstrate that TFSI not only enhances ~5-fold the PL emission, Fig. 1a, but also boosts by over one order of magnitude the EL-EQE in WS_2-based LEDs at room temperature, Fig.1b. TFSI treatment also restores the neutral exciton (X^0_{EL}) behaviour by tuning the WS_2 carrier concentration.

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Figures

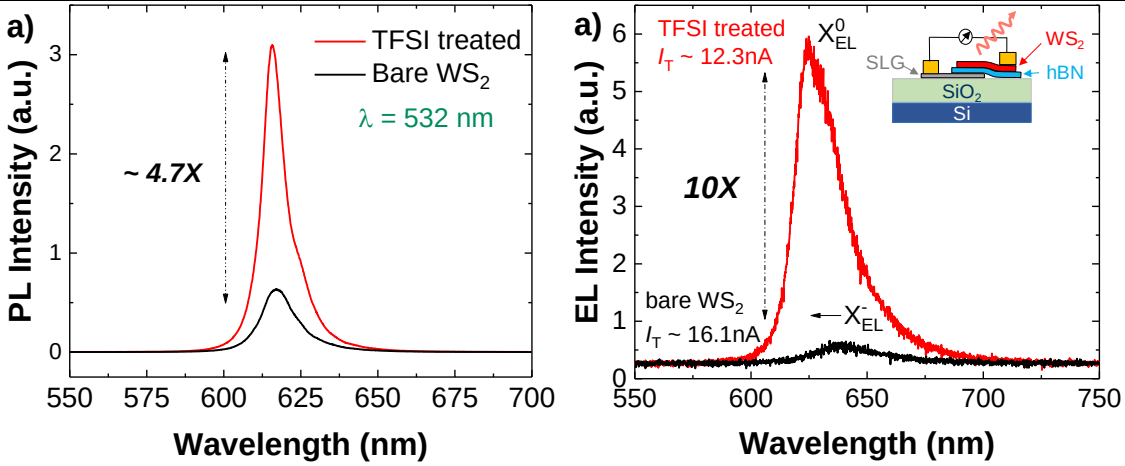

Figure 1: (a) PL and (b) EL emission before and after TFSI treatment.