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Local Strain Induced Bandgap Modulation and Photoluminescence Enhancement of Multilayer Transition Metal Dichalcogenides

Abstract

The Photocarrier relaxation between direct and indirect band gaps along the high symmetry K-Γ line in the Brillion zone reveals interesting electronic properties of the transition metal dichalcogenides (TMDs) multilayer films.[1] In this study, we reported on the local strain engineering and tuning of an electronic band structure of TMDs multilayer films along the K-Γ line by artificially creating one-dimensional wrinkle structures. Significant photoluminescence (PL) intensity enhancement in conjunction with continuously tuned optical energy gaps was recorded at the high strain regions. A direct optical band gap along K-K points and an indirect optical gap along Γ−K points measured from the PL spectra of multilayer samples monotonically decreased as the strain increased, while the indirect band gap along □-Γ was unaffected owing to the same level of local strain in the range of 0%–2%. The experimental results of band gap tuning were in agreement with the density functional theory calculation results. Local strain modified the band structure in which K-conduction band valley (CBV) was aligned below the □-CBV, and this explained the observed local PL enhancement that made the material indirect via the K-Γ transition. The study also reported experimental evidence for the funneling of photo generated excitons toward regions of a higher strain at the top of the wrinkle geometry.

Keywords: Multilayer; Local strain; PL enhancement; Band structure; Exciton funneling

Reference

[1] Zhao, W.; Ribeiro, R. M.; Toh, M.; Carvalho, A.; Kloc, C.; Castro Neto, A. H.; Eda, *Nano Lett.* 2013, *13*, 5627.

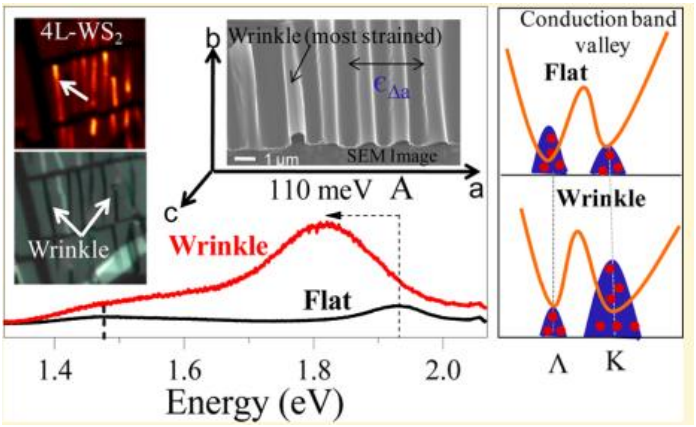

Figure: Illustration of the optical properties modulation on the wrinkle region of the 4L WS_2 film through PL mapping analysis. Schamatic at the right showed the band structure modulation duie to local strain effect.