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Dependence of Monolayer WS_2-Substrate Interaction on Substrate Type and Bonding Investigated by High-temperature Raman and Photoluminescence LIQIN SU, Univ of NC - Charlotte, YIFEI YU, LINYOU CAO, North Carolina State University, YONG ZHANG, Univ of NC - Charlotte
— We report the temperature and excitation wavelength dependence of the electronic and vibration properties of epitaxially grown WS_2 monolayers on different substrates, SiO_2 and sapphire, using photoluminescence (PL) and Raman spectroscopy with temperatures up to 500 °C. Similar to our previous study on MoS_2 (Su *et al.*, Nanoscale 6, 4920, 2014), the WS_2 monolayers are shown to also exhibit strong interaction with substrates, manifesting as that their electronic and optical properties depend sensitively on the substrate type and film-substrate bonding. Raman frequency shifts for $E^1_{2g}(\Gamma)$ and $A_{1g}(\Gamma)$ modes and PL energy shifts are measured from room temperature up to 500 °C. Raman spectra shows strong substrate dependence, and the thermal quenching of the PL intensity in the high temperature region reveal nonradiative channels with large activation energies in the order of 0.5 eV. This study suggests the critical need to assess the potential impact of the substrate on the intrinsic properties of such 2-D materials and the opportunities for tailoring their properties by selecting different substrates.

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