Esaki Diode at Room Temperature Based on $WSe_2/SnSe_2$ Heterostructure with Tailored Interface

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Abstract

Vertically stacked two-dimensional van der Waals (vdW) heterostructures, used to obtain homogeneity and band steepness at the interface, exhibit promising performance for band-to-band tunneling devices. Esaki tunnel diodes based on vdW heterostructures, however, yield poor current density and peak-to-valley ratios, inferior to those of three-dimensional materials. We report the negative differential resistance behavior with the planar tunneling property in $WSe_2/SnSe_2$ heterostructure system at room temperature and demonstrate that heterointerface control is key to achieving high device performance by constructing $WSe_2/SnSe_2$ heterostructures in inert gas environments. While devices fabricated under ambient conditions showed poor device performance due to the observed oxidation layer at the interface, devices fabricated in inert gas environments exhibited extremely high peak current density up to 1460 mA/mm^2, 3-4 orders of magnitude higher than reported vdW heterostructure-based tunnel diodes, with a peak-to-valley ratio over 4 at room temperature. Diode behavior can be further modulated by controlling the electrostatic doping and the tunneling barrier as well.

Figures

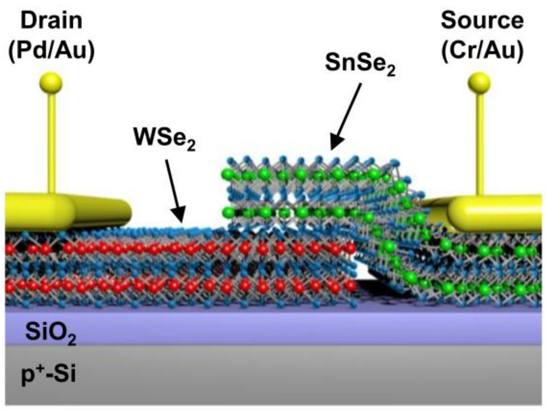

Figure 1: Schematic of device structure.

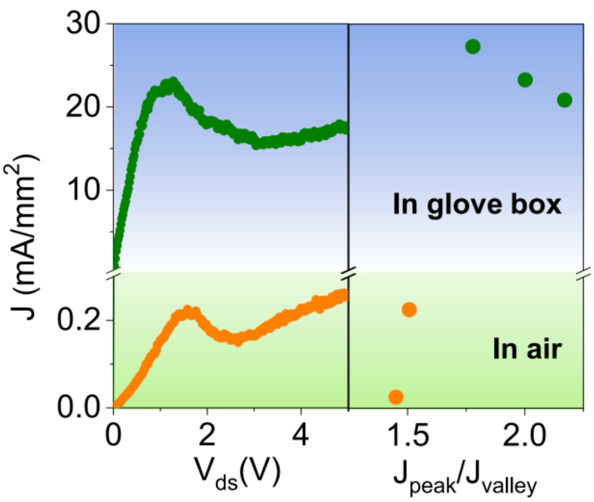

Figure 2: NDR behavior of devices fabricated in each environment at room temperature (left) and the reproducibility (right)