# Fast-Response Single-Nanowire Photodetector Based on ZnO-WS2 Core-Shell Nanowire Heterostructures

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The surface plays an exceptionally important role in nanoscale materials, exerting a strong influence on their properties. Consequently, even a very thin coating can greatly improve the optoelectronic properties of nanostructures by modifying the light absorption and spatial distribution of charge carriers. To use these advantages, ZnO-$WS_2$ core/shell nanowires with a-few layers thick $WS_2$ shell were fabricated. These heterostructures were thoroughly characterized by scanning and transmission electron microscopy, X-ray diffraction, and Raman spectroscopy. Then, a single-nanowire photoresistive device was assembled by mechanically positioning ZnO-$WS_2$ core-shell nanowires onto gold electrodes inside a scanning electron microscope. The results show that a few layers of $WS_2$ significantly enhance the photosensitivity in the short wavelength range and drastically (almost 2 orders of magnitude) improve the photoresponse time of pure ZnO nanowires. The fast response time of ZnO-$WS_2$ core-shell nanowire was explained by electrons and holes sinking from ZnO nanowire into $WS_2$ shell, which serves as a charge carrier channel in the ZnO-$WS_2$ heterostructure. First-principles calculations suggest that the interface layer i-$WS_2$, bridging ZnO nanowire surface and $WS_2$ shell, might play a role of energy barrier, preventing the backward diffusion of charge carriers into ZnO nanowire.

References

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Figures

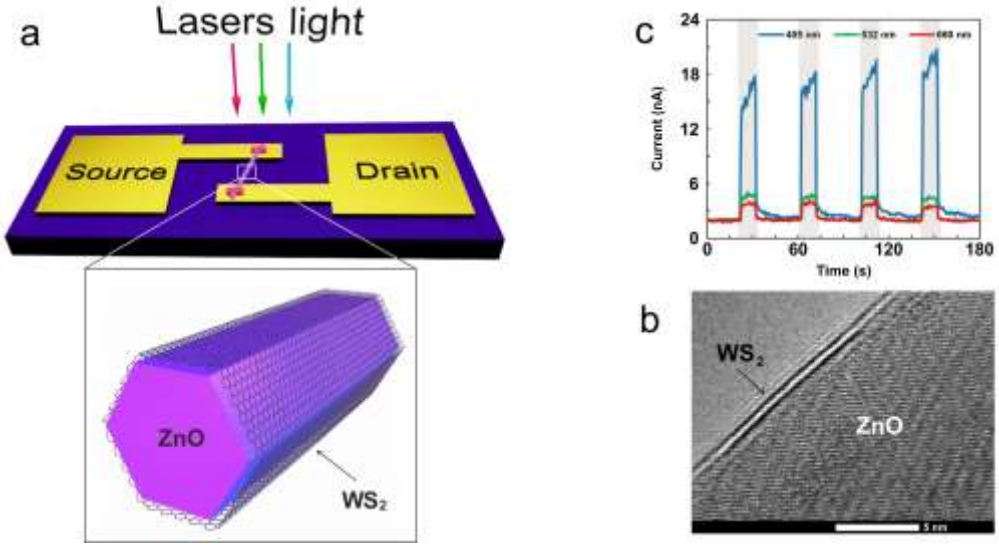


**Figure 1:** Schematics of ZnO-$WS_2$ core-shell nanowire-based photodetector (a). TEM image of a ZnO-$WS_2$ core-shell nanowire (b). On−off photoresponse measurements of ZnO-$WS_2$ nanowire at 1 V bias voltage and light illumination using 0.5 W/cm$^2$ light intensity of 405, 532, and 660 nm wavelengths (c).