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High Photosensitivity and Broad Spectral Response of Multi-Layered Germanium Sulfide Transistors

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Abstract : In this paper, we report the optoelectronic properties of multi-layered GeS nanosheets (~28 nm thick)-based field-effect transistors (called GeS-FETs). The multi-layered GeS-FETs exhibit remarkably high photoresponsivity of Rλ ~ 206 AW-1 under illumination of 1.5 μW/cm2 at = 633 nm, Vg = 0 V, and Vds = 10 V. The obtained Rλ ~ 206 AW-1 is excellent as compared with a GeS nanoribbon-based and the other family members of group IV-VI-based photodetectors in the two-dimensional (2D) realm, such as GeSe and SnS2. The gate-dependent photoresponsivity of GeS-FETs was further measured to be able to reach Rλ ~ 655 AW-1 operated at Vg = -80 V. Moreover, the multi-layered GeS photodetector holds high external quantum efficiency (EQE ~ 4.0 × 104 %) and specific detectivity (D* ~ 2.35 × 1013 Jones). The measured D* is comparable to those of the advanced commercial Si- and InGaAs-based photodiodes. The GeS photodetector also shows an excellent long-term photoswitching stability with a response time of ~7 ms over a long period of operation (>1 h). These extraordinary properties of high photocurrent generation, broad spectral range, fast response, and long-term stability make the GeS-FET photodetector a highly qualified candidate for future optoelectronic applications.

Keywords : germanium sulfide, photodetector, photoresponsivity, external quantum efficiency, specific detectivity
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