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High photosensitivity and broad spectral response of multi-layered germanium sulfide transistors

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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.

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Meta-model based optimization approaches to thin film solar cell design

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Designing nano-scale materials with high external quantum efficiency is a complicated inverse design problem requiring the optimization of a utility function derived from the solution of an underlying dynamic system governed by electromagnetic Maxwell and electronic carrier mobility equations. Such as design usually consists of layering or texturing the semiconductor material with metallic reflectors, nano-particles or wave-guides, transparent conductive layers, surface roughness, and other simultaneous light trapping/career mobility improvement mechanisms, and therefore lies within an extremely vast search space. The design problem is consequently very time consuming and challenging, and offers little intuitive understanding of the intertwined effects of joint variable deltas. These types of design problems can be handled more practically via the use "meta-model" optimizations. The idea is such approaches are that the utility function is locally or globally fit with an approximate meta-model based on past search points or carefully designed experiment points. The meta-model is then used as a guide to carry out a simpler optimization closely resembling that of the original design, or to recommend valuable candidate points. In the current work, we report on using a variety of such meta-model approaches to design highly efficient thin film silicon solar cells with multi-layered front and back coatings. We apply different meta-model optimization techniques to the proposed problem and compare the results to standard numerical optimization algorithms. In particular, we propose two novel techniques that have their roots in machine-learning applications; one based on a regularized linear local fit and the other one based on a global regression-tree fit, and we demonstrate that the with the help of these smart techniques we can indeed expedite nano-material search problems to a great extent.

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