Large size and high productive growth of SnS_2 nanoflakes for good performance photodetecting application

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Abstract:

2D SnS2 has exhibited good performance in many applications and especially in photodetectors due to its fast response rate, high on/off ratio, high responsivity, and good stability, but high-quality growth and high performance photodetecting of 2D SnS2 still face great challenges. We developed a simple and fruitful recipe to synthesize SnS2 nanoflakes using a one-step CVD method with separate reaction and deposition zones that may effectively increase the deposition efficiency of high-quality crystals and assist in precisely understanding the growth and deposition temperature of SnS2. High-quality SnS_2 nanoflakes with large-size and high-production are vertically grown, having an average size of 30 μm with different thicknesses. Based on a single SnS_2 nanoflake on SiO2/Si substrate, high current on/off ratio FET and highly sensitive phototransistors were obtained, showing fast response rates, high responsivity and external quantum efficiency. Specifically, the SnS_2 nanoflakes show the thickness-dependent photodetection capability and the highest responsivity of 354.4 A W^{-1} is obtained at the average thickness of 100.5 nm. A sensitized process using HfO_2 nanolayer can further enhance the responsivity up to 1922 A W^{-1}. Our works provide an efficient CVD method to prepare SnS_2 crystal samples with the optimal thickness as promising candidates for high-performance optoelectronic applications.