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Recent Progress in the Uncooled Mid-Infrared Lead Selenide Polycrystalline Photodetector

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Abstract : Currently, the uncooled PbSe photodetectors in the mid-infrared range (2-5μm) with sensitization technology extract more photoelectric response than traditional ones, and enable the room temperature (300K) photo-detection with high detectivity, which have attracted wide attentions in many fields. This technology generally contains the film fabrication with vapor phase deposition (VPD) and a sensitizing process with doping of oxygen and iodine. Many works presented in the recent years almost provide and high temperature activation method with oxygen/iodine vapor diffusion, which reveals that oxygen or iodine plays an important role in the sensitization of PbSe material. In this paper, we provide our latest experimental results and discussions in the stoichiometry of oxygen and iodine and its influence on the polycrystalline structure and photo-response. The experimental results revealed that crystal orientation was transformed from (200) to (420) by sensitization, and the responsivity of 5.42 A/W was gained by the optimal stoichiometry of oxygen and iodine with molecular density of I2 of ~1.51×1012 mm-3 and oxygen pressure of ~1Mpa. We verified that I2 plays a role in transporting oxygen into the lattice of crystal, which is actually not its major role. It is revealed that samples sensitized with iodine transform atomic proportion of Pb from 34.5% to 25.0% compared with samples without iodine from XPS data, which result in the proportion of about 1:1 between Pb and Se atoms by sublimation of PbI2 during sensitization process, and Pb/Se atomic proportion is controlled by I/O atomic proportion in the polycrystalline grains, which is very an important factor for improving responsivity of uncooled PbSe photodetector. Moreover, a novel sensitization and dopant activation method is proposed using oxygen ion implantation with low ion energy of < 500eV and beam current of ~120μA/cm2. These results may be helpful to understanding the sensitization mechanism of polycrystalline lead salt materials.

Keywords : polycrystalline PbSe, sensitization, transport, stoichiometry
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