Snowflakes Patterns Formation Enhances Performance of Nanostructure-based MWIR PbSe Photoconductive Detector

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We present a novel approach to fabricate a PbSe thin film photoconductive detector using the chemical bath deposition technique, resulting in the formation of various snowflakes-like patterns on the active area of the detector. Our findings reveal the presence of clusters of nanostructures, primarily nanoprisms, beneath the snowflakes patterns, which enhance the performance of the PbSe photoconductive detector. This is a new observation that has not been previously reported.

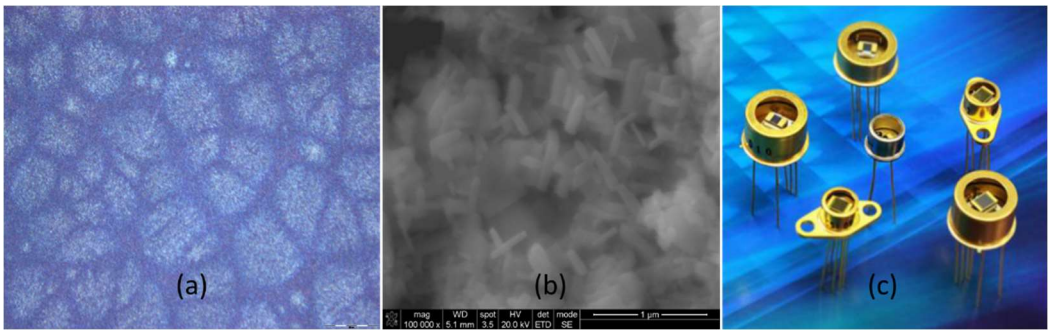

Figure 1(a) shows a micrograph of the snowflakes patterns, while Figure 1(b) shows the formed nanoprisms entangled with each other, which were revealed after etching the oxide phases of the PbSe matrix. Examples of PbSe detectors (www.optodiode.com) fabricated based on such nanostructures are shown in Figure 1(c). It is clear that underneath the snowflakes patterns, many nanoprisms are developed, massively entangled together, and form clusters of nanostructures.

Our investigations have shown that when snowflakes-like patterns appear on the surface of the detector's active region, a large number of PbSe nanostructures are formed within the PbSe thin film. We have also found a strong correlation between the size and compactness of the snowflakes patterns, and thus the nanostructures, and the performance of the PbSe photoconductive detector. As the snowflakes patterns get larger, the detection signal tends to be stronger.

We have examined changes in the microstructure and carrier concentrations resulting from sensitizing treatments such as oxygen and iodine. Our findings suggest that the snowflakes patterns are a direct evidence of the crystallization process. Finally, we have thoroughly examined the FTIR spectral response of the nanostructure-embedded PbSe photoconductive detector at various temperatures ranging from 77K to 340K.

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