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Lead Selenide Transport and Conductivity Mechanism

Lead selenide (PbSe) photoconductors are very popular type of lead salt photodetectors in the infrared spectrum because of their excellent room temperature operation, outstanding price to performance ratio and large detector area manufacturability. Main application areas of the PbSe photodetectors are medical and environmental gas analysis, process control, flame and fire detection and optical pyrometry. However, their photoconductive and carrier transport mechanism has not been well understood so far. Laser Components DG, Inc. (LCDG) is a leading vendor of the PbSe photodetectors and fabricates PbSe polycrystalline thin film detectors using chemical bath deposition (CBD) technique. After the deposition, the thin film PbSe detectors are sensitized by oxidation and iodization. The completed LCDG detectors have sheet resistance values of about 1 MΩ per square. In order to ascertain the photoconductive and transport mechanisms of the LCDG detectors they have been characterized by a number of material characterization and electro-optic techniques. The characterization results suggest that only p-type PbSe detectors are photosensitive and that their photoconductivity is based on majority hole carrier transport. The PbSe detector thin films consist of grains and connecting tissue. The grains are lead selenide while the connecting tissue is a combination of lead selenide and lead oxide, likely as PbSeO3. The I-V characteristics of the completed PbSe are very linear pointing to no barrier related hole transport that takes place in the connecting tissue. The oxidation of a deposited PbSe film is required for its photosensitivity but introduces substantial nonlinearity and dramatic changes in its hole mobility. The iodization restores linearity of the I-V characteristics and substantially increases photosensitivity of the PbSe photodetectors. The characterization results fully support the number modulation model while being inconsistent with the recently proposed charge separation junction model.

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Biography

Davorin Babić received M Sc. and Ph.D. degrees from the University of Pennsylvania, Philadelphia, PA USA where he investigated and achieved deposition of amorphous GeSe2 from an organic solution of $GeSe_2$ crystalline powder and developed new insight into models of the structure of amorphous As2S3 and As2Se3 by calculating their electronic structure. In 1991 he became Research Assistant Professor at University of North Carolina at Charlotte studying optoelectronic properties of silicon quantum dots caused by electrostatic screening and modifications of dielectric function in the nanoscale and he co-developed a novel technique for measurement of barrier height distribution at Si/SiO2 interface. He joined the University of Illinois at Chicago in 1994 where he conducted research on Si surface passivation in Si doped TMAH solution, observed Si surface passivation in Si doped KOH solution and proposed a model for the passivation mechanism. In 2002 he joined Johnson Research and Development where he developed novel devices and systems for energy storage and conversion. He invented a highly conductive amorphous lithium ion conducting solid electrolyte prepared by sol gel technique. He also developed electrochemical cells that utilize thin film proton conducting ceramic electrolyte. He joined Laser Components DG, Inc. in 2014 where he currently directs research and development of novel photodetectors and improvements of already existing photodetectors with special focus on the infrared. He is a member of SPIE and has 50 publications including 14 patents and 6 pending patent applications.

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