Skysong Innovations
Advancing the Arizona State University Knowledge Enterprise

1475 N. Scottsdale Road, Suite 200
Scottsdale, AZ 85287-3538
Phone: 480 884 1996 Fax: 480 884 1984

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Inventors

Michael Stueckelberger
Xiaogang Yang
Mariana Bertoni

Contact

Shen Yan
shen.yan@skysonginnovations.com

Reconstructing Charge Collection Efficiency in Three Dimensions

Background The charge collection efficiency is a critical metric to evaluate the local electrical performance of optoelectronic devices. For example, defects show up as reduced charge collection efficiency. In two dimensions, the charge collection efficiency can, for example, be evaluated by the analysis of laser-beam induced current (LBIC), electron-beam induced current (EBIC), or X-ray beam induced current (XBIC), relying on the electrical response of the device under test (DUT) upon raster-scanning the DUT by a respective beam. Unfortunately, it is not trivial to get any depth information based on these measurements, and the quantification of the charge collection efficiency based on the beam-induced current measurements is prone to errors due to the lack of depth information along the beam path. There are currently no non-destructive methods to evaluate the charge collection efficiency in three dimensions. Invention Description Researchers at Arizona State University and Deutsches Elektronen-Synchrotron (DESY) have developed a solution for measuring charge collection efficiency in all three dimensions of space. First, electron-hole pairs are generated in the DUT using an X-ray beam (or alternatively: electron, proton, ion, or visible-light beam). Utilizing two external contacts to the DUT, the charges can be extracted and quantified in the form of XBIC. Using a dedicated setup that is capable of scanning the sample with the X-ray beam in three dimensions (typically two linear motions perpendicular to the beam and one rotational motion perpendicular to the beam), a dataset of the XBIC signal is obtained. This innovation covers an algorithm that reconstructs the three-dimensional charge collection efficiency in the DUT, compensating for artifacts such as varying X-ray absorptance. Potential Applications • Laboratory X-rays sources • Semiconductor device characterization • 3D electrical mapping Research Homepage of Professor Mariana Bertoni