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Optoelectronic diffusion waves in semiconductors: carrier lifetime chronotomography imaging of Si solar cells

Photocarriers in semiconductors excited by modulated laser sources give rise to diffusion waves that can be used to study and characterize the electronic properties of materials and devices. In this talk the concept of carrier diffusion waves will be introduced. Then, lock-in carrierography (LIC), a near-infrared (NIR)- camera-based quantitative diffusion-wave methodology developed in the CADIPT for non-destructive imaging of electronic materials and devices, will be presented. With the recent advent of the heterodyne mode (HeLIC), high-frequency imaging up to and beyond 100kHz has been achieved, which allows hundred-Hz frame-rate NIR cameras to map out carrier-diffusion-wave microsecond recombination dynamics in active optoelectronic devices like solar cells. Beyond today's state-of-the-art single effective- lifetime imaging, the high-frequency information from HeLIC can help resolve multiple carrier recombination rates/ lifetimes.

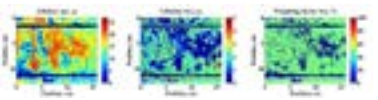


Fig.1. Introducing a resonant modality between modulation frequency and decaying photocarrier temporal profiles in Si solar cells

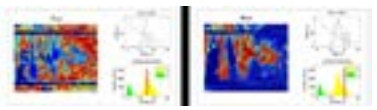
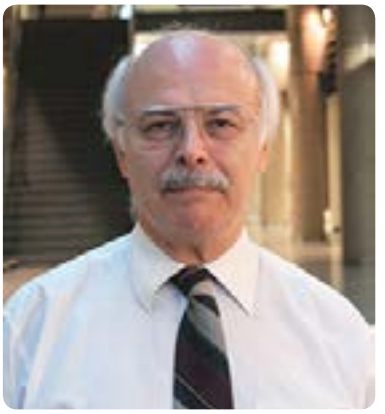


Fig.2. the resulting time-resolved tomography (coined definition: "lifetime chronotomography") will be shown to give rise to three- dimensional space-time reconstructions of superposed multiple lifetime modes in solar cells, thus providing novel penetrating physical insights into the solar energy conversion/loss mechanisms.



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Biography

Andreas Mandelis is a full Professor of Mechanical and Industrial Engineering; Electrical and Computer Engineering; and the Institute of Biomaterials and Biomedical Engineering, University of Toronto. He is the Canada Research Chair in Diffusion-Wave and Photoacoustic Sciences and Technologies and Director of the CADIPT at the University of Toronto. He is the CTO of Quantum Dental Technologies, Inc. and CEO and President of Diffusion-Wave Diagnostic Technologies, Inc., both located in Toronto. He is the author and co-author of 410+ scientific papers in refereed journals and 190+ scientific and technical proceedings papers. Professor Mandelis has received numerous national and international prizes and awards.

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