Development of Transport Imaging Technique

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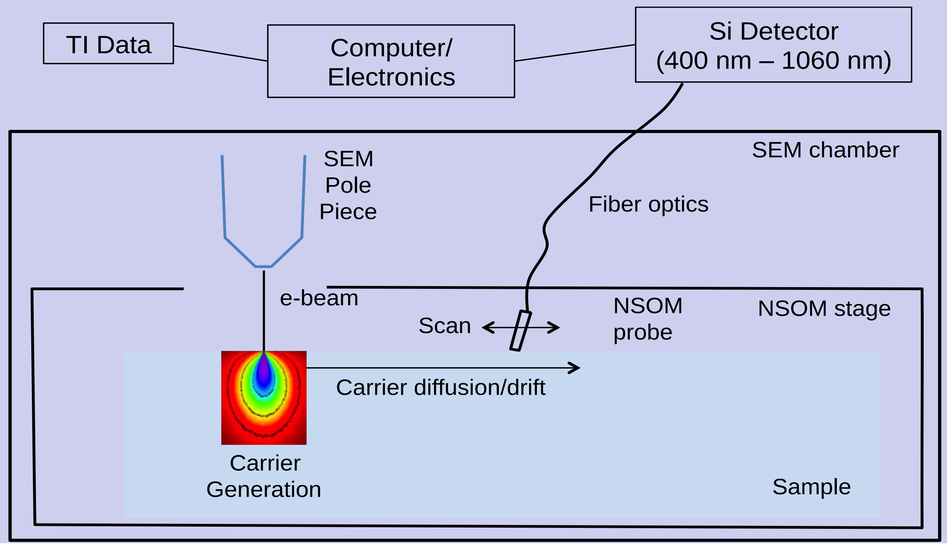
***Transport Imaging (TI) is an innovative approach that integrates a scanning electron microscope with a near-field scanning optical microscope. The goal is* to "see" the transport of carriers and determine minority carrier diffusion lengths from a single image and map spatial variations in drift and diffusion behavior properties.**

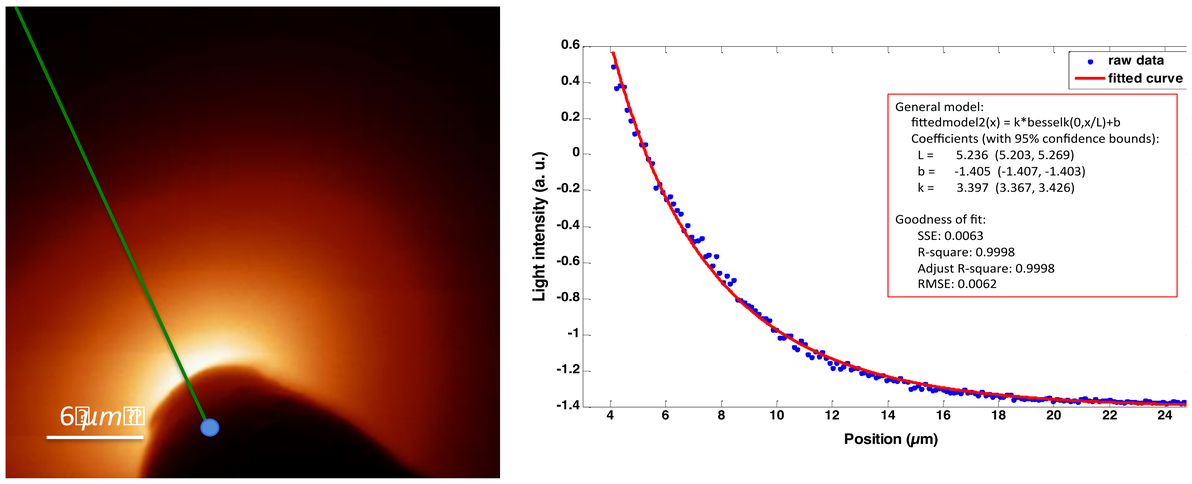
Setup schematic:



Technique advantages:

1. Direct imaging of minority carrier diffusion/drift
2. Generation and detection of recombination at any specific location of interest
3. Direct determination of diffusion length in single films and devices
4. Investigation of carrier kinetics in a wide-range of inhomogeneous mediums involving extended defects, grain boundaries, interfaces, etc.
5. Nanometer-scale resolution

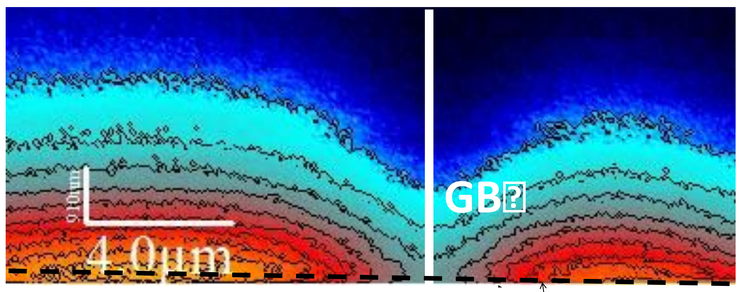
Diffusion length on GaAs



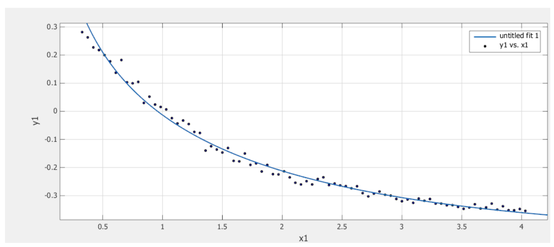
Left) TI image for a GaAs single crystal sample with a 30-nm InGaP cap layer, the blue dot indicates the position of the electron beam (not size); right) fitting linescan curve in Matlab to determine diffusion length

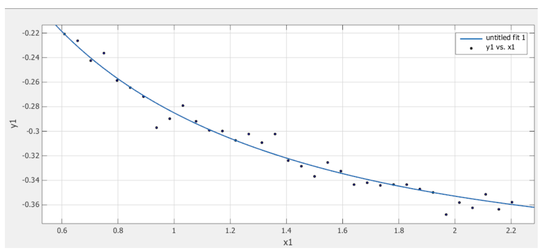
Measurement of diffusion length directly from TI data on single film (no device required)

Effect of boundary on CdTe bicrystal

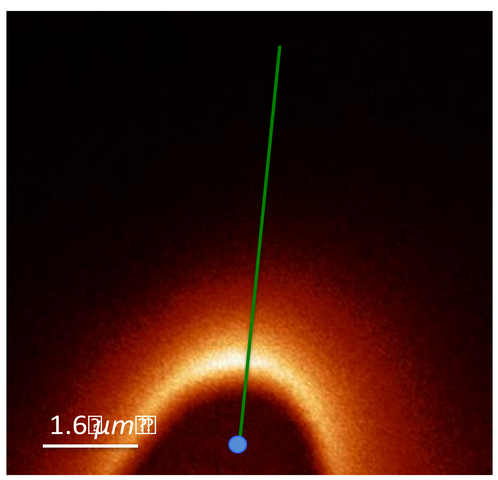


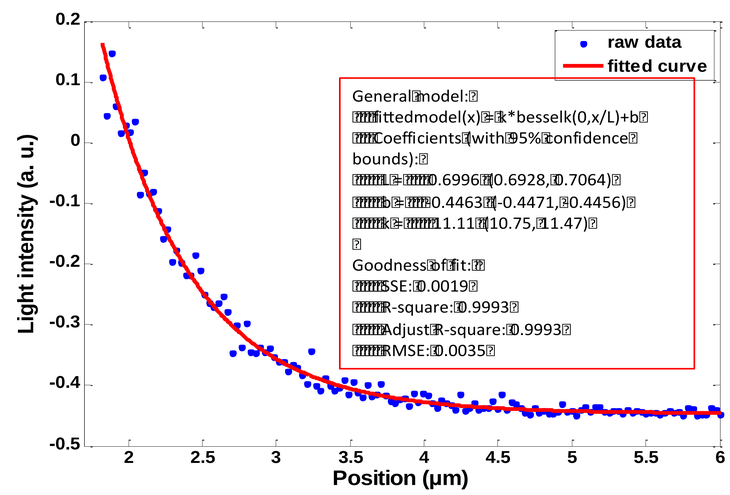
- ***Electron beam scanned in a line perpendicular to grain boundary***
- ***Enhanced charge carrier recombination at the boundary***
- ***Measurement of diffusion length at regions few micrometers apart***





Diffusion length on CdTe

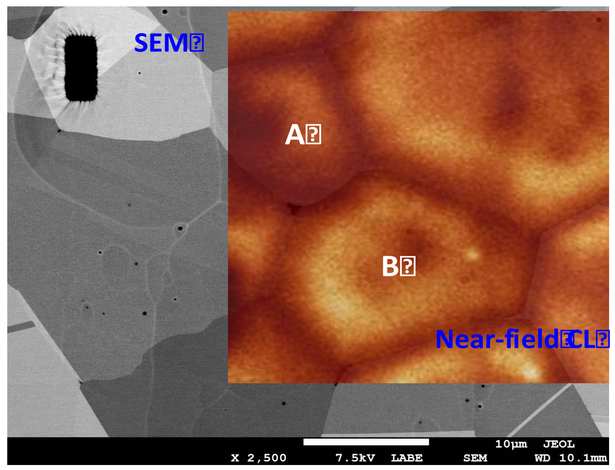


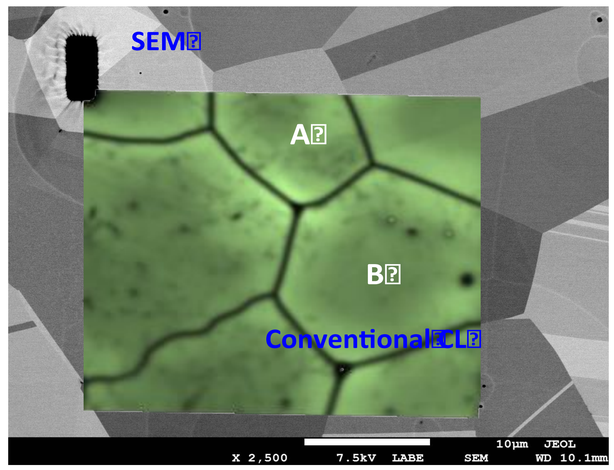


Left) TI data from a CdTe thin film; b) fitting linescan curve in Matlab to determine diffusion length

- ***First ever TI application on polycrystalline thin film solar cell material***
- ***Direct measurement of diffusion length of CdTe***
- ***Potential to investigate carrier transport properties in individual grains and grain boundaries***

Near-field CL vs. conventional CL of CdTe





Comparison between near-field CL (left) and conventional CL (right) analyses on a CdTe thin film.

- ***Near-field probes the recombination signal close to the generation point, conventional CL measures total luminescence plotted at the point of generation***
- ***An additional mode of analysis that makes the TI technique more versatile***

 Solar Show & Tell and Holiday Celebration □ Golden, CO □ Dec. 15, 2016