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Ion Beam Induced Current Measurements of Solar Cells with Helium Ion Microscopy

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The scanning electron microscope (SEM) is a versatile high-resolution microscopy tool, and perhaps the most widely used imaging platform across many engineering and scientific fields [1]. Within the last decade, another microscopy technique based on a gaseous field ionization source, utilizing Helium and Neon ions has been introduced [2]. While the popularity of the SEM is hardly challenged by the Helium Ion Microscopy (HIM), there are instances when imaging with ions offers significant advantage as opposed to imaging with electrons. In principle, both HIM and the SEM share many similarities, for example, a HIM operating at 40 keV will generate ions with velocity comparable to SEM operating at 5 keV. However, due to much higher stopping power of ions, as compared to electrons, ion based secondary electron (iSE) will be higher. Also, as a result, there is little ion backscattering, and consequently, the concentration of the ion-generated iSE2 (additional secondary electron generated by SE interaction within the material) is usually insignificant.

In this work, we exploit small interaction volumes in the HIM, and take advantage of the lower iSE2 yield, and positively charged helium ions to map ion beam induced current (IBIC) in solar cell materials. Similar studies, using electrons, have visualized induced current profiles at grain profiles in polycrystalline solar cells, and in silicon [3, 4]. Furthermore, broad ion sources have been utilized in conjunction with scanning probe systems in the past to map out current changes in FinFETs [5]. We are interested in utilizing the HIM to map current at the nanoscale near *p-n* junctions in CdTe to elucidate differences in contrast captured by the ion beam induced current, as opposed to the electron beam induced current. These findings will illustrate the peculiarities of ionic transport in these solar cell materials, and will evaluate the HIM technology as a potential quality control tool.

Figure 1 illustrates a custom National Instruments DAQ based beam position and blanker control system, utilized in conjunction with the standard microscope controller in order to control the beam position and trajectory, to correlate with the current output as measured by the DLPCA-200 current amplifier.

Figure 2 is a preliminary current map acquired at the edge of the solar cell device, mapping out the conductive (lighter) and poorly conductive (darker) areas of the PCB.

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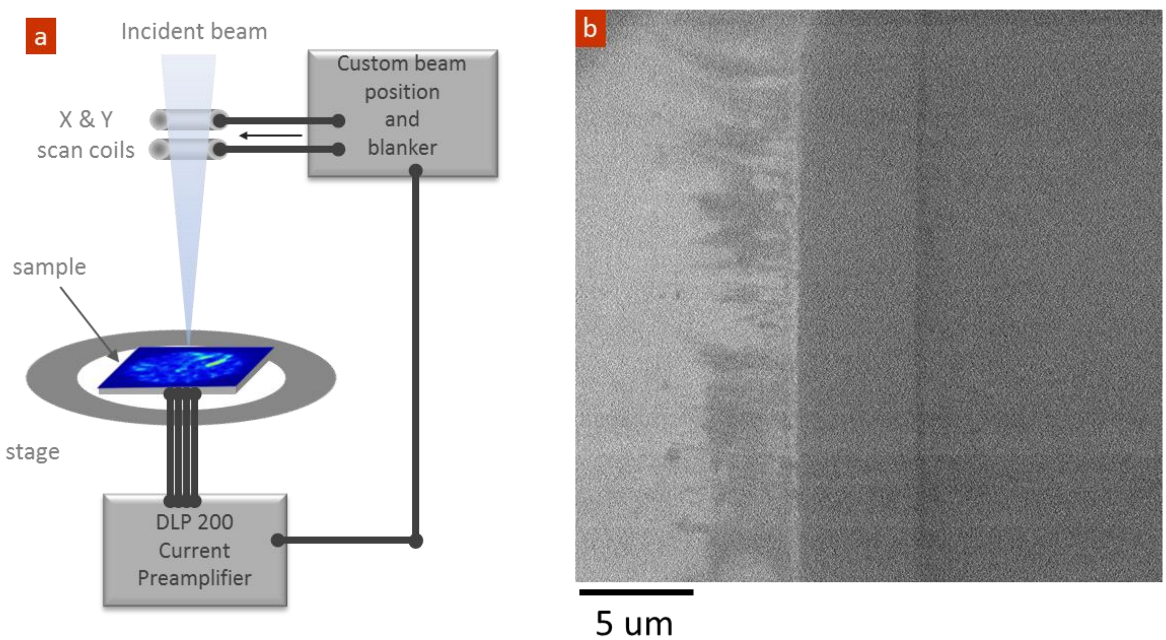

Figure 1. Controller and a preliminary result of a HIM based, *in-situ* ion beam induced current measurement. (a) Schematic of a setup. We utilized a custom National Instruments DAQ control circuit to control the trajectory and dwell time of the ion beam, the blanker, and handle the processing of the current pre-amplifier signal. (b) Preliminary results of current mapping on a PCB mapping out the conductive (lighter) and poorly conductive (darker) areas.

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