Area: Crystalline and Thin Film Silicon PV

EVALUATION OF EFFECTIVE DIFFUSIVITIES AND THREE-DIMENSIONAL SIMULATION OF CARRIER DISTRIBUTION IN PHOSPHORUS-IMPLANTED EMITTER OF SI SOLAR CELL USING SCANNING NONLINEAR DIELECTRIC MICROSCOPY

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At first, scanning nonlinear dielectric microscopy (SNDM) was applied to the cross section of phosphorus implanted emitter in monocrystalline silicon solar cell and visualized the carrier distribution quantitatively. The result is shown in Figure 1. The active dopant in the side position is one-dimensionally distributed along the direction of the arrow. Therefore, the P distribution at the side region was analyzed on the basis of the implanted P distribution in the flat (not textured) substrate.

The distribution can be roughly described as two distinct regions, i.e., the surface and tail regions. A Gaussian function was applied to the P distribution at the surface and tail regions in the side position. The dashed lines in Figure 2 show the fitting results. As shown in Figure 2, two Gaussian functions describe the P distribution well. Effective diffusivities of $D^{Surface}=9.4\times10^{-15}$ cm^2/s in the surface region and $D^{Tail}=1.3\times10^{-13}$ cm^2/s in the tail region were obtained from the fitted Gaussian function in the surface and the tail region, respectively. Since each pyramid has four faces, the P distributions in the direction vertical to the faces are expected to be the same. In this case, we can roughly simulate the 3D P distribution at the upper part of the pyramidal base using the superposition of Gaussian functions in Figure 2. Figure 3(a) shows the 3D carrier distribution using the superposition of P distributions. Figure 3(b) shows its cross section at y=0. Line profiles at the convex and side positions in Figure 3(b) are shown as red and green solid lines in Figure 3(c), respectively. The line profiles obtained from the 3D distribution are in good agreement with that obtained from the SNDM results.

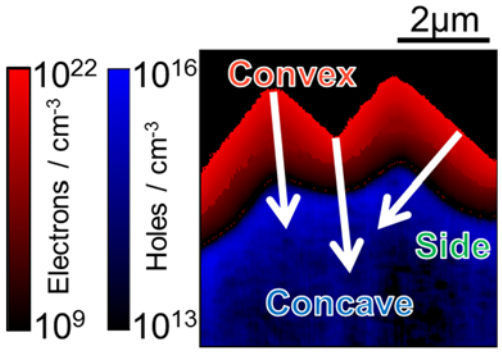

Figure 1: Image of quantitative carrier distribution in the phosphorus-implanted emitter of monocrystalline silicon solar cell measured by using SNDM.

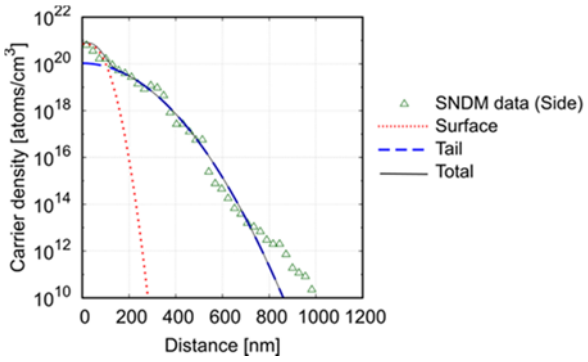

Figure 2: Line profiles of active dopant in the side position in Figure 1 and two fitted Gaussian functions applied to the P distribution at the surface and tail regions .

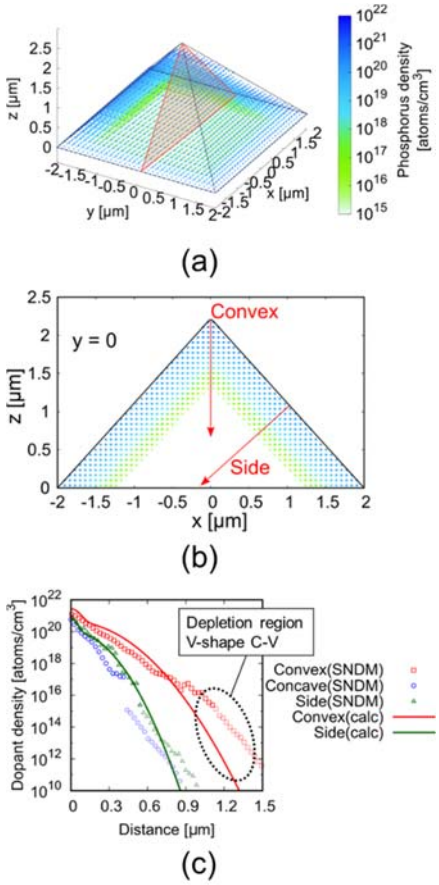

Figure 3: (a) Simulated 3D carrier distribution using the superposition of P distributions. (b) Cross section at y=0. (c) Line profiles at the convex and side positions in (b) are shown as red and green solid lines with their measured data by SNDM, respectively.