Relationship between Abnormal Temperature Dependence of Hole Concentration in p-type Polycrystalline Si Wafer and Efficiency of Solar Cell

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Efficiency of polycrystalline silicon (poly-Si) pn solar cells (η), which are fabricated using wafers that are sliced out of p-type poly-Si ingots, strongly depends on where it is taken from within the ingot. The wafers near the bottom or top of the ingot cannot be used for solar cells. We measured the temperature dependence of the hole concentration $p(T)$ in p-type poly-Si wafers, and investigated the dependence of $p(T)$ on the position of the wafer within the ingot. It has been found that $p(T)$ are classified into three categories, including an abnormal $p(T)$.

300 μm-thick poly-Si wafers, that the ingot was horizontally sliced into, were used. The dependence of η on the position of the wafer within the ingot is shown in Fig. 1. Figure 2 shows a set of three $p(T)$ corresponding to sample numbers of N35, N37 and N48 in Fig. 1.

Although η corresponding to N35 and N48 are both low, it has been found that two $p(T)$ are quite different each other. Particularly, the $p(T)$ near the bottom of the ingot decreased rapidly with an increased temperature of 250 K to 300 K. This behavior was abnormal. From the analysis [1] of $p(T)$, acceptor densities of boron (B) in N35, N37 and N48 were determined to be 2.2×10^{16}, 1.5×10^{16} and 1.5×10^{16} cm^{-3}, respectively, where the $p(T)$ lower than 200 K were used in N35 and N37. In N48, two acceptor species besides the B acceptor were found. The acceptor level and density of one acceptor were 83 meV and 4.9×10^{15} cm^{-3} respectively, while those of the other were 189 meV and 7.2×10^{14} cm^{-3} respectively.

The relationship between η and $p(T)$, as well as the origin of 83 meV and 189 meV acceptor species has been investigated. Moreover, the understanding of the abnormal $p(T)$ is in progress.

Reference

[1] H. Matsuura, Y. Masuda, Y. Chen and S. Nishino, Jpn. J Appl. Phys. 39 5069 (2000).

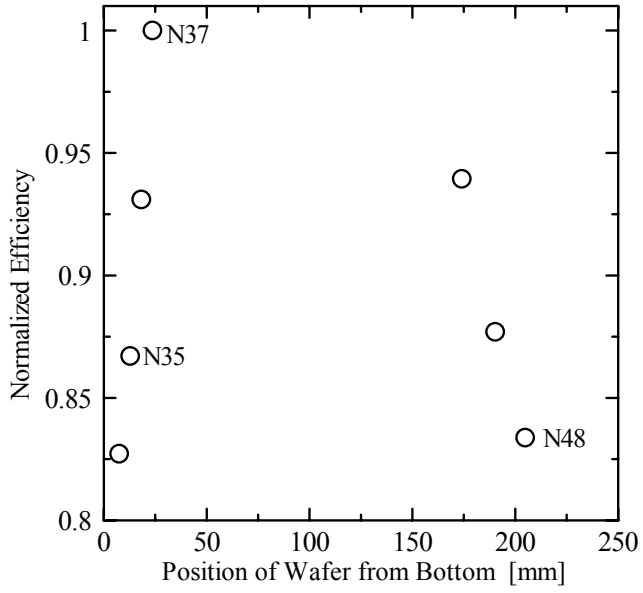

Fig. 1 Dependence of normalized efficiency on position of wafer from bottom.

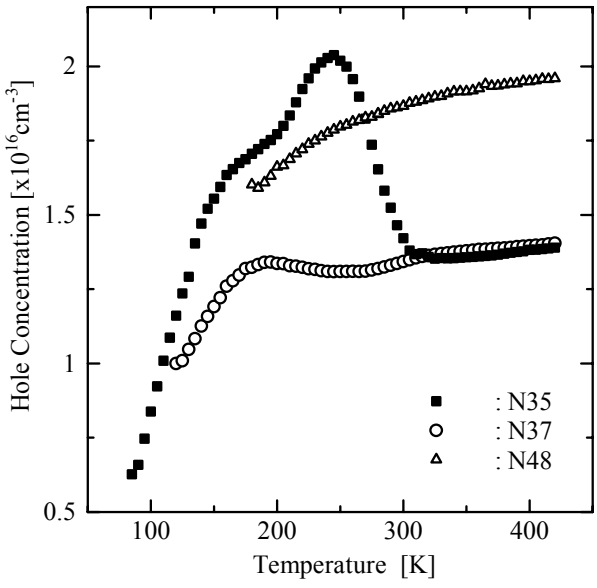

Fig. 2 Three kinds of $p(T)$