Electrical conduction of Si/ITO/Si junctions fabricated by surface activated bonding

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***Abstract*—The electrical properties of n-Si/ITO/n-Si, n-Si/ITO/p-Si, and p-Si/ITO/n-Si junctions fabricated by surface activated bonding (SAB) were investigated. The current-voltage (*I-V*) characteristics of n-Si/ITO/n-Si, n-Si/ITO/p-Si, and p-Si/ITO/n-Si junctions showed excellent linearity. The interface resistance of n-Si/ITO/p-Si junctions was found to be 0.0249 Ω·cm^2, which is the smallest value observed in all the samples.**

I. Introduction And Background

The bonding technique of dissimilar materials at room temperature such as surface activated bonding (SAB) enables us to construct the new device structures, which were very difficult to fabricate up to now by the conventional techniques [1, 2]. We previously fabricated InGaP/GaAs/Si triple-junction cells by using SAB and characterized their electrical properties, in which GaAs/Si tunnel junction has been utilized to the connection of the sub-cells [3]. The resistance across the bonded interfaces is still higher in comparison with that of monolithically grown tunnel junctions. The conductive oxide layer-mediated junction is considered to be the most effective way for lowering the loss of the interface resistance and transmission.

In this work, as the preliminary experiment we fabricated n-Si/ITO/n-Si, n-Si/ITO/p-Si, and p-Si/ITO/n-Si junctions using surface activated bonding (SAB) technology and investigated their electrical properties by measuring current-voltage (*I-V*) characteristics. The structural properties of the bonded interfaces were examined by field emission scanning electron microscopy (FE-SEM).

II. Results

The cross-sectional FE-SEM image of Si/ITO/Si junctions is shown in Fig. 1. The three-layer structure was observed in the junctions. The top, middle and bottom layers of the junctions are Si, ITO, and Si, respectively. No structural deficits or hollow spaces were observed around the bonded interface. Figure 2 shows the *I-V* characteristics of n-Si/ITO/n-Si, n-Si/ITO/p-Si, and p-Si/ITO/n-Si junctions measured between -0.03 and 0.03 V at room temperature. We found that the *I-V* characteristics shown in this figure revealed excellent linear properties. The interface resistances of n-Si/ITO/n-Si, n-Si/ITO/p-Si, and p-Si/ITO/n-Si junctions were estimated to be 0.0296, 0.0249, and 0.0291 Ω·cm^2, respectively, by least-squares fitting at approximately 0 V. The resistance of n-Si/ITO/p-Si junctions is the smallest value for all the junctions.

The results of our experiments show that ITO as an intermediate layer is suitable for the connection of the tandem sub-cells.

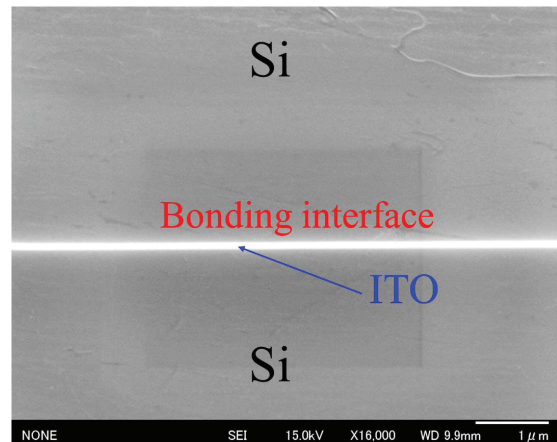

Fig. 1. Cross-sectional FE-SEM image of Si/ITO/Si junctions.

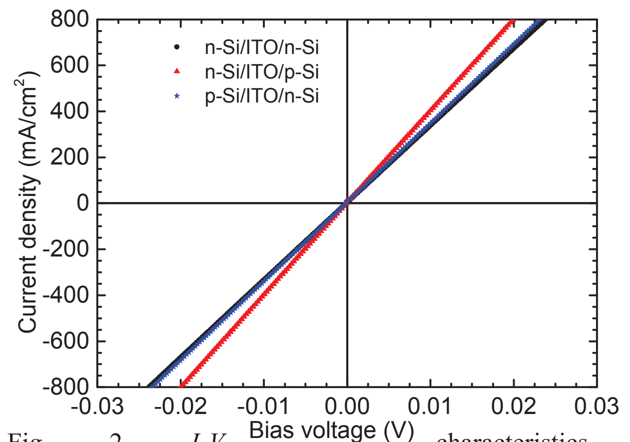

Fig. 2. *I-V* characteristics of various types Si/ITO/Si junctions measured at room temperature.

Acknowledgment

This work was supported by "Development of high performance and reliable PV modules to reduce levelized cost of energy" project for the New Energy and Industrial Technology Development Organization (NEDO) in Japan.

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