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多結晶シリコン中転位分布の不均一性の解析

The origin of inhomogeneous dislocation distribution in multicrystalline silicon

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Multicrystalline silicon (mc-Si) materials are widely used for solar cell applications due to reasonable cost performance. It is well known that crystallographic defects like dislocations and grain boundaries (GBs) limit the performance of mc-Si solar cells. Recently, with the advances in casting crystal growth technology, it is possible to grow large grain mc-Si in which the number of grain boundaries can be greatly reduced. However, high density dislocations still present in these materials and tend to be the key defects in future photovoltaic Si materials. It is frequently observed that the density of dislocations vary over different grains. Heavily dislocated regions limit the photovoltaic performance and thus should be avoided. At present, there is a lack of systematical study about dislocation and its related defects in mc-Si. The interaction between dislocations and GBs may result in a more complicated distribution of dislocations.

This work attempted to clarify the origin of inhomogeneous dislocation distribution by taking into account of effects of grain orientation and boundary character. Electron back-scattered diffraction (EBSD) was used to analyze grain orientation and boundary character. Low temperature electron-beam-induced current (EBIC) was employed to study defect distribution as well as their electrical activities. Figure 1 show two neighboring grain in a mc-Si sample, in which Grain-1 (red in color) contained higher density dislocations than Grain-2 (blue in color) as revealed by EBIC observation at 100 K. The large difference in dislocation density can be explained by Taylors' model, which describes deformation in polycrystals based on slip in individual grains. It is concluded that Taylor factor is a good measure of dislocation distribution in mc-Si. Grain of lower values of Taylor factor has more efficient slip sets and a great tendency to be dislocation-rich region in mc-Si crystals.

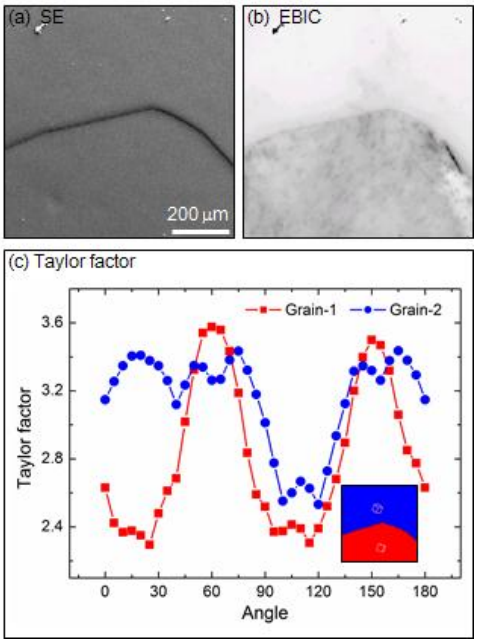

Fig. 1 SE, EBIC images and Taylor factor statistics of two neighboring grains in a mc-Si wafer.

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