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Grain Evolution in Multicrystalline Silicon Grown from Small Randomly Oriented Seeds

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Multicrystalline silicon (mc-Si) is the dominant material for solar cells and with improved efficiency; the high performance mc-Si (HP mc-Si) will play an important role in the future of the solar industry. In contrast to conventional mc-Si, the HP mc-Si grows from very small grains. However, the grain evolution for mc-Si grown from small grains in the directional growth setup is unclear.

To investigate the grain evolution, test ingots of 100mm diameter were grown by directional solidification from template with randomly oriented grains with an average size of 100 μm. Vertically and horizontally cut wafers were analyzed using electron backscatter diffraction (EBSD).

Previous results, mainly from vertical wafers suggested that the growth can be described in 3 stages, namely initial, transient and steady. However, the factors affecting the 3 stages were unclear. This study focuses on clarifying these factors. Fig 1 a) shows the inverse pole figure (IPF) from EBSD for the horizontally cut wafers of the template. b) and c) show the IPF for horizontal wafers for growth height of 1mm and 16mm respectively. From a) and b) it can be seen that the grain structure of the grown mc-Si even at 1mm height is very different from the template. From b) and c) it can be seen that the grain size increases with growth and there is no distinct difference in grain shape perpendicular to growth direction. In contrast, the vertical wafers, which are parallel to growth direction, showed spherical and columnar grains for 1mm and 16mm respectively. The horizontal wafers also showed that some grain orientation become dominant at latter stage of growth. The results suggest that factors such as grain boundaries and grain orientation may affect different stages of growth.

a) **b)** **c)**

Fig 1 Inverse pole figures (IPF) of horizontal wafers of a) microcrystal template, and mc-Si from b) 1mm and c) 16mm growth heights.

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