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Directional Growth of Multicrystalline Silicon from Microcrystal Feedstock

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Multicrystalline silicon (Mc-Si) is a dominant material for photovoltaic application. However, due to the presence of extended defects such as grain boundaries (GBs) and dislocations the efficiency is slightly lower in comparison to monocrystalline silicon. Hence, larger grain size and lower dislocation density is necessary to increase the efficiency of the Mc-Si. It is therefore very important to deeply understand the grain growth and defect formation mechanism in Mc-Si. In this study, grain growth mechanism was investigated in Mc-Si grown by the widely used directional solidification method in cast furnace using quartz crucible coated with silicon nitride [1].

Usually when Mc-Si is grown by the directional solidification method, the feedstock is completely melted and crystal growth happens from the bottom of the crucible. However, to investigate the grain growth behaviour from microcrystal template, test ingots of about 100mm diameter were grown where the feedstock (average size < 100 μm) was intentionally left in the silicon melt to act as a microcrystal seed. Figure 1a. shows Mc-Si (Ingot 1) grown at 15mm/h, and it can be seen that the grains grown from the feedstock gradually increased in size becoming more and more columnar with growth height. To clarify the influence of growth speed, Ingot 2 (Figure 1b.), was grown with identical growth conditions as Ingot 1, but at 45mm/h growth rate. As can be seen in Figure 1b., unlike Ingot 1, the grains were columnar from the initial stages of growth, and the grain size perpendicular to the growth orientation was much smaller in comparison to Ingot 1. The quality of the ingots grown at these two different conditions will be discussed with respect to dislocation density and GB distribution.

a. **b.**

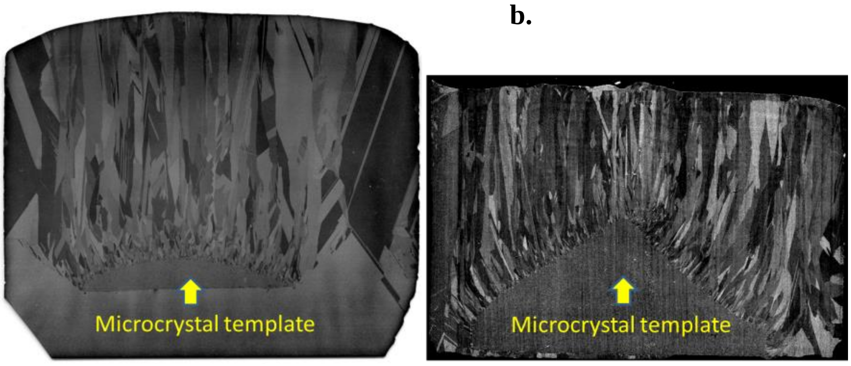

Figure 1.　Mc-Si grown from microcrystal template at **a.** 15mm/h, **b.** 45mm/h growth rate

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Reference: [1] K. Arafune et al., J. Crystal Growth, 308 (2007) 5.