Growth of mc-Silicon ingot by DS Process: Experimental and Machine Learning

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Mc-Si ingots were grown in a DS furnace system that was built in India. The top and side graphite heaters, the heat exchanger, the insulations, the thermocouples, the adjustable insulation (slit valve), and the gas control systems make up the DS system. Solid polycrystalline Si feedstock with a 9N purity level is placed into a square-shaped quartz crucible with an incubation layer (SiN) covering and placed in the hot zone of the DS system to create a silicon ingot. The insulating loop encloses the heated zone, which is covered by the chiller. In the quartz crucible, the feedstock Si is entirely melted. Next, the heat from the melted feedstock Si is dissipated by implementing a temperature gradient in the hot zone that is created by opening the insulating loop. The crystal's growth rate was kept constant at 1 centimetre per hour. Following the melting, the controlled solidification caused a mc-Si ingot with dimensions of 220 mm by 220 mm by 125 mm to grow. After the ingot had grown, it was divided into blocks and then, using an indigenously designed and manufactured multi-abrasive diamond single wire saw, it was further divided into wafers. Using numerous reflection pictures, we create a machine learning model to quickly forecast crystal orientations in the large-area mcSi wafer. In particular, numerous reflection pictures are gathered by circling the wafer 360° with the incident illuminating light. Afterward, a machine learning model with long short-term memory neural network might be employed as the input with an intensity profile for each crystal grain. The crystal orientations obtained by the Laue diffraction method were used to train the model. The results contrast (a) those observed by the Laue diffraction method and (b) those projected orientation distributions by the artificial neural network. The estimation errors' distribution is also taken into account, and it was discovered that the median estimation error was 3°. This approach will be used for the etched M10 wafer because it is accurate enough.