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Users watch growth of defects in silicon

The ESRF's ID19 and BM05 beamlines have enabled scientists to watch the growth of carbon based defects in silicon. The results could help in the development of silicon photovoltaics that are less affected by carbon impurities. Carbon is a common impurity in photovoltaic silicon, entering the crystal as carbon monoxide, which is formed by the contact of oxygen with neighbouring graphite components in industrial furnaces. Once inside, it can make the silicon harder to cut into ingots for wafer preparation, and initiates several types of crystal defects, which impact on both electrical and mechanical performance once the wafers are made into solar cells, reducing photovoltaic efficiency. According to researchers at the CNRS Institute of Materials Microelectronics and Nanosciences of Provence (IM2NP), and Aix-Marseille Université, both in France, “post mortems” of silicon ingots reveal little about how these defects develop.

For that reason, in collaboration with the ESRF, the researchers developed a special high temperature (2070 K), directional solidification furnace that allowed them to watch the defects as they grow *in situ* and in real time, via X-ray radiography and Bragg diffraction imaging at ID19. Additional rocking-curve measurements (see « Rocking it”, left) at BM05 quantified the degree of deformation, and revealed sub-grains, after solidification in both the ID19 model sample and industrial ingots. The results showed that carbon is at the origin of defects generated during solidification across several scales, in both model samples and industrial ingots (*Acta Mater.* 252 2023 118904). The IM2NP team says that the knowledge could help in the control of silicon solidification to avoid the formation of carbon-related defects, or to evaluate the incidence of carbon contamination in recycled silicon.

« Rocking it »

Rocking-curve imaging is an advanced X-ray Bragg diffraction imaging technique, newly developed at the ESRF's BM05 beamline. More accurate (albeit slower) than white-beam topography, it can characterise defects in bulk crystals, as well as crystalline layers with a thickness in the micron range. It is particularly geared towards the characterisation of high-quality crystals with sub-micron spatial resolution and micro-radian angular resolution (*Microelectron. Eng.* 276 112012).