X-ray topographic characterization of structural defects in thick epitaxial silicon for solar cells

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Reducing production costs of solar cells is still a key element in achieving a fast transformation to renewable energies. The use of silicon wafers grown by direct chemical vapor deposition of an epitaxial layer on a porous substrate promises a significant reduction of resource and energy consumption in the silicon wafer production. The main challenge in establishing this process is to overcome the efficiency limits caused by structural defects like stacking faults and dislocations [1,2]. Consequently, these defects need to be reduced, and tracking the generation of defects plays a key role in the improvement of the processes as well as in the quality control.

In our contribution, we have studied crystallographic defects in thick epitaxial silicon, using a lab-scale x-ray topography (XRT) tool. We have observed different types of dislocations, including edge-type misfit dislocations as well as threading dislocations with different Burgers vectors. These threading dislocations can either be threading segments of the misfit dislocations or be introduced independently of the lattice misfit. Using cross-section topographs, the three-dimensional structure of these dislocations was identified and dislocations in the substrate and the epilayer can so be distinguished without detachment of the epilayer. We have also detected the stacking fault defects and mapped their density distribution over the wafers. The difference in the observed contrast of stacking faults was additionally used to classify different types of stacking fault defects regarding their shape and their decoration with dislocations.

Our results demonstrate that XRT is a nondestructive method enabling the fast detection of structural defects on full wafer scale and consequently the evaluation of wafer quality. In addition, it can be used for a local investigation on the character of these defects.

References

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