A Study of the Electrical Activity of Crystal Defects in Multicrystalline Si

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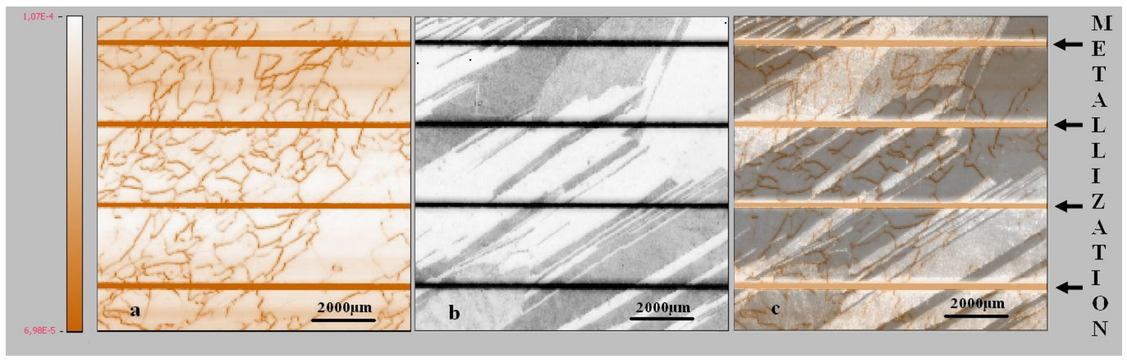
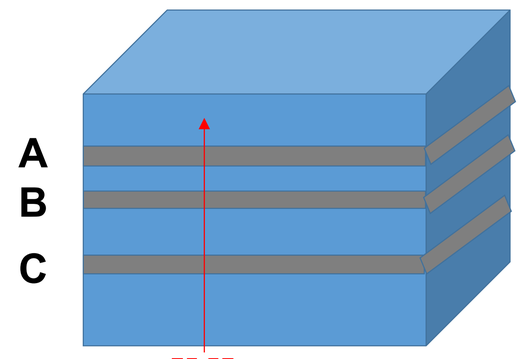
- **Crystal defects are usually trapping centers for the photogenerated carriers in multicrystalline silicon (mc-Si) solar cells.**
- **The presence of metallic impurities reduces the carrier lifetime and the photovoltaic efficiency.**
- **mc-Si contains extended defects, namely grain boundaries (GBs), sub-grain boundaries and dislocations, which are claimed to be responsible for killing the carrier lifetime.**
- **The electrical activity of these extended defects depends on their interaction with the metallic impurities.**
- **Upgraded metallurgical-grade silicon (UMG Si) solar cells are very useful to study this interaction because of its high impurity content.**
- **Several UMG cells made on wafers cut from the same brick at different heights were studied by LBIC, the same grains were localized in the cells, allowing a comparative analysis in terms of the cell efficiency and the metallic impurity content.**



LBIC **Reflected light** **LBIC + Reflected light**

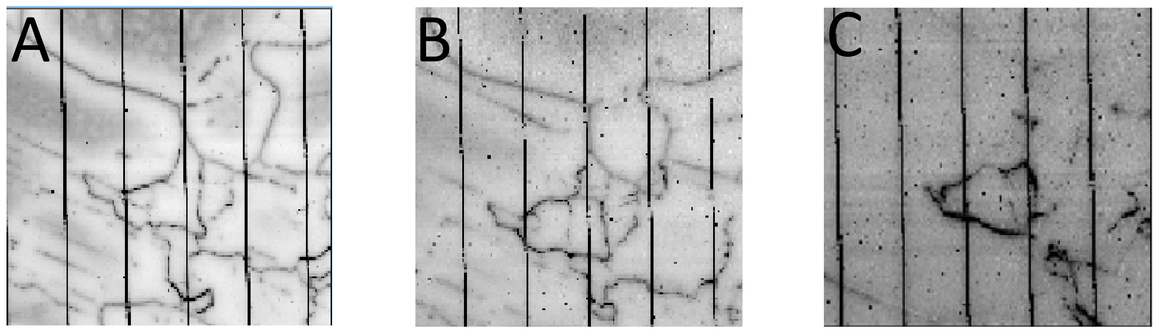
- **In purified mc-Si the trapping activity of GBs is very low.**
- **The dark contrast in LBIC images is associated with sub-grain boundaries**



Cell Efficiency

15-16.6 %
17.2-17.4%
17.7-17.8%

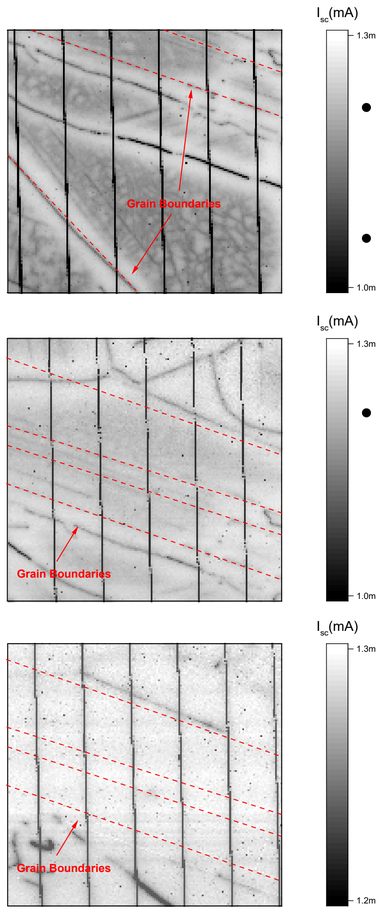
[M] Metal impurity concentration



Same structure of defects
Different electrical activity

GBs

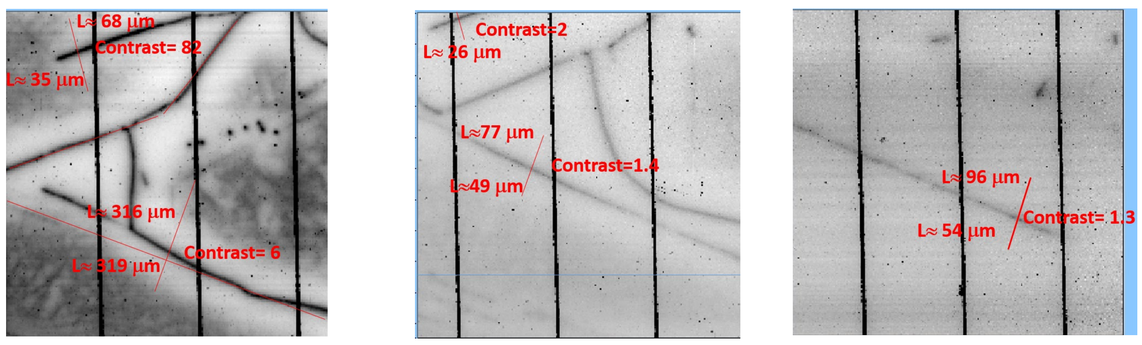
LBIC



- **The dark contrast of GBs increases from C to A.**
- **GB electrical activity depends on the concentration of metallic impurities.**
- **All the GBs are active in sample A, while the dark contrast in GBs of sample C is almost unappreciable.**

GBs revealed in the reflected light image

Diffusion length



A **B** **C**

The diffusion lengths estimated are longer in sample A, which is due to the distribution of metallic impurities around the defects, either sub-grain boundaries or GBs.
The L parameter in metallic impurity rich wafers is not a diffusion length, it is rather determined by the impurity distribution around the crystal defects.

- **The electrical activity of the extended defects is greatly influenced by the presence of metallic impurities.**
- **The activity of GBs depends on the background metallic impurities, as [M] decreases the GBs loss its electrical activity.**
- **Instead, the sub-grain boundaries present a higher electrical activity, even if [M] is reduced.**
- **The measure of the diffusion length in the presence of high concentrations of metallic impurities can be misleading.**

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