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► **To cite this version:**

M. Pasquinelli, N. M’Gaffad, H. Amanrich, L. Ammor, S. Martinuzzi. EXTRINSIC ORIGINE OF RECOMBINATION CENTRES AT GRAIN BOUNDARIES IN P TYPE SILICON BICRYSTALS. Journal de Physique Colloques, 1989, 50 (C6), pp.C6-159-C6-159. 10.1051/jphyscol:1989619 . jpa-00229650

HAL Id: jpa-00229650

<https://hal.science/jpa-00229650>

Submitted on 4 Feb 2008

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EXTRINSIC ORIGIN OF RECOMBINATION CENTRES AT GRAIN BOUNDARIES IN P TYPE SILICON BICRYSTALS

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The origin of recombination centres at grain boundaries (G.B.'s) $\Sigma 9$ and $\Sigma 13$ in "CZ" grown bicrystals, doped with 10^{15} cm⁻³ boron atoms, has been investigated. L.B.I.C. scan maps at $\lambda = 940$ nm and global capacitive measurements (C-V plots, DLTS) applied to the space charge region of G.B.'s, have been used. The first technic allows the local determination of interfacial recombination velocity S, while the second one leads to average values of energy E_T , density N_T and cross section σ_T of recombination centres of G.B.'s. Doping atoms profiles can also be obtained within G.B.'s.

The results indicate that the two types of G.B.'s, and particularly $\Sigma 9$ have not a noticeable recombination activity in the as grown bicrystals. Annealings at temperatures about 600°C, at least, during several hours are needed to activate $\Sigma 13$ G.B.'s heterogeneously.

The average values of E_T obtained by DLTS are in the range between 0.4 and 0.5 eV. For such values, it was reported that oxygen or SiO_x precipitates could be the source of these deep levels /1/.

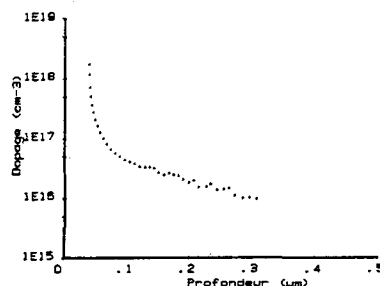
In addition, Batistella et al. /2/ have observed that the activation of G.B.'s is heterogeneous and due to localized recombining clusters.

As the investigated "CZ" silicon contains a large amount of oxygen, it could be assumed that oxygen segregation by G.B.'s explains the enhancement of recombination activity during the annealings. $\Sigma 9$ G.B.'s remain poorly recombining, probably because dopant atoms have been segregated during crystal growth, as suggested by the doping profile within a G.B. given by figure 1.

References

- /1/ K. SCHMALZ, F.G. KIRSCHT, H. KLOSE, H. RICHTER and K. TITTELBACK-HELMRICH, Phys. Status Solid (a) 100 p.567 (1987).
- /2/ F. BATISTELLA et A. ROCHER, Proc. of 6th European Photov.Sol.En.Conf. London, April 1985, pp.113-117.

Fig.1. Net density of negative charges in the space charge region of $\Sigma 9$ GB after annealing at 900°C during 24H.



(1) on leave of the E.N.S. of Takaddoum-Rabat, Maroc