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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.archives-ouvertes.fr/jpa-00229650
Submitted on 1 Jan 1989

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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) Σ9 and Σ13 in "CZ" grown bicrystals, doped with 10¹⁵ cm⁻³ boron atoms, has been investigated. L.B.I.C. scan maps at λ = 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 Eₜ, density Nₜ and cross section σₜ 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 Σ9 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 Σ13 G.B.'s heterogeneously.

The average values of Eₜ obtained by DLTS are in the range between 0.4 and 0.5 eV. For such values, it was reported that oxygen or SiOₓ 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. Σ9 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

Fig.1. Net density of negative charges in the space charge region of Σ9 GB after annealing at 900°C during 24H.