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INFRARED LBIC SCAN MAPS APPLIED TO ALUMINIUM GETTERED MULTICRYSTALLINE SILICON WAFERS

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The use of thin wafers (d < 200 μm) of improved P type multicrystalline wafers to make solar cells call for the use of a back surface field effect realized at low temperatures (< 800°C). Diffusion of aluminium could be successfully used because Al is an acceptor in silicon, Al diffuses more rapidly than boron and Al layers are used as ohmic contacts. In addition it is known that the annealing of an Al-Si interface at temperatures between 400 and 800°C improves the minority carrier diffusion lengths L_n. It is interesting to verify if this annealing reduces the recombination strength of grain boundaries (GBs) or of extended intragrain defects like dislocations and subgrain boundaries. Near infrared LBIC scan mapping is a suited technique (fig.1)

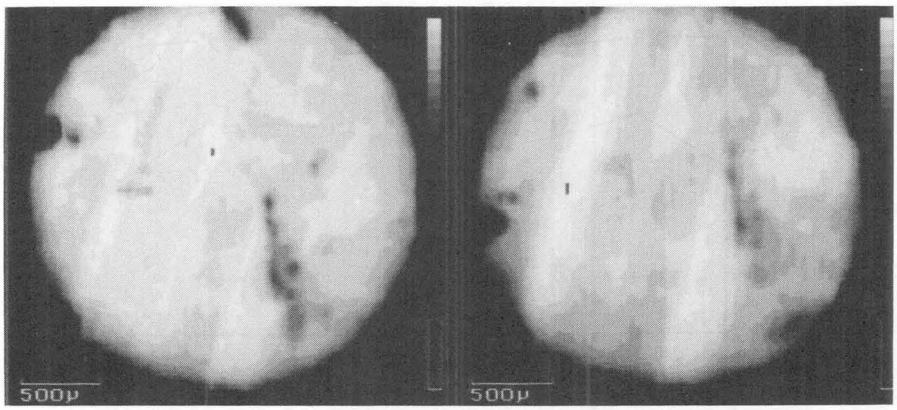

Fig.1. LBIC scan maps (λ = 940 nm) for a gettered material (left) and a gettered and Aluminium treatment sample (right)

P type Polix wafers cut adjacently in the same ingot have been studied. They presented the same distribution and nature of defects. Series of matched samples (2 x 2 cm^2) were cut out of the wafers and submitted to phosphorus diffusion by the two surfaces, at 850°C for 12 and 240 mn. The longer diffused samples were called gettered, while the 12 mn were labeled standard.

N^+P mesa diodes were revealed on one face and the other face was chemically etched and

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then covered by a thick (1 μm) Al layer. Then the structure was annealed at 800°C for 30 mn in argon and at 450°C for 30 mn to get an ohmic contact only. Effective diffusion lengths L_n have been determined from the spectral variation of the photocurrent in the near infrared.
It was found that L_n increases drastically in the gettered samples and reaches at least the sample thickness after the annealing. LBIC scan maps at λ = 940 nm indicate that the recombination strength of GBs is reduced while the photocurrent in the grains, specially in dislocation containing regions, are enhanced (fig.1). The standard samples are less improved (fig.2), than the gettered wafers (fig.3)).

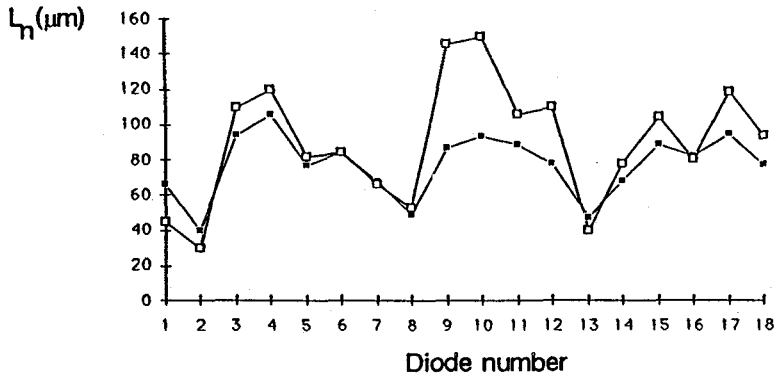

Fig.2. Diffusion length variations after annealing of standard samples for 30 mn (■ 450°C , □ 800°C).

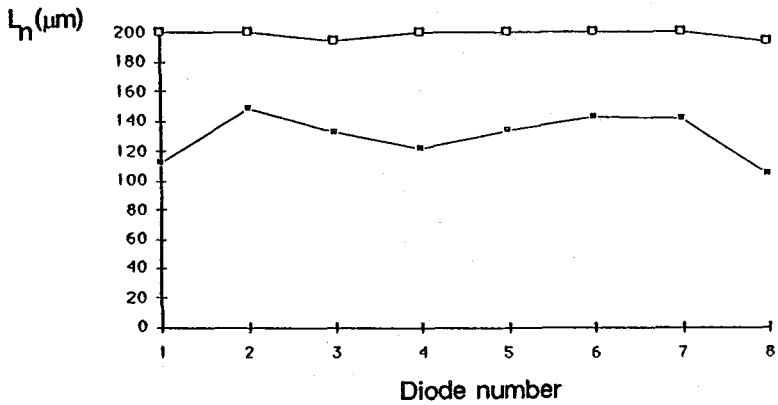

Fig.3. Diffusion length variations after annealing of gettered samples for 30 mn (■ 450°C , □ 800°C).

It is concluded that the improvement of L_n is due to an aluminium intragrain defects interaction which neutralizes recombination centers, or to a backside gettering effect of impurities which cannot be removed by the phosphorus gettering. This external gettering is able to remove fast diffusers and impurity atoms which diffuse more rapidly than silicon self interstitials and not other impurity atoms like oxygen.
However the existence of a back surface field effect is not precluded in the gettered samples in which the diffusion lengths reach 150 μm (so around 2/3 of the thickness).