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TEMPERATURE DEPENDENCE OF CL AND EBIC IMAGES OF DISLOCATED GaAs AND Si

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The interactions of dislocations with impurities and/or point defects in GaAs and Si crystals with various thermal histories are investigated by observing the temperature dependence of the CL and EBIC images. Since the impurity distribution around a dislocation changes drastically with temperature, the specimens with different thermal histories show various CL or EBIC contrasts reflecting the distribution of impurities and/or point defects.

(1) CL in GaAs

LEC-grown GaAs crystals doped with different concentrations of Si are studied by means of cathodoluminescence. The observations at room temperature with a Si photomultiplier reveal the followings. The higher the Si concentration is, the stronger the CL intensity is. The CL contrast is rather uniform throughout the specimen of a high doped crystal, while a contrast pattern related to the distribution pattern of dislocations is observed in a low doped crystal. An investigation\(^1\) is done to see how the CL contrast pattern is influenced by thermal history of the specimen with a low doped crystal with Si the electron concentration of which is \(1 \times 10^{16} \text{ cm}^{-3}\). In an as-grown crystal the grown-in dislocations are observed as dark spots with bright regions around them. A specimen rapidly cooled after annealing at 1050°C shows a uniform CL contrast. On the other hand, the specimen slowly cooled from 1050°C shows the CL contrast similar to that in the as-grown crystal. This results from the interaction between dislocations and the non-radiative recombination centers. Various heat treatments of the specimens reveal that the impurities related to non-radiative recombination centers are getterted by dislocations most effectively at temperature around 750°C.

Temperature dependence of the CL contrast is studied with the same specimen using a Ge detector. The spatial distribution of CL intensity shows a quite complicated change with respect to the temperature of the observation. The CL intensity is rather uniform at temperatures below 40K irrespective of dislocation distribution. In the temperature range 50 to 80K the CL intensity around a dislocation becomes strong. At 120K another contrast pattern which is not related to the dislocation distribution is developed. At room temperature the regions in the vicinity of dislocations show much stronger CL than in the regions far from dislocations.

(2) EBIC in cast Si

Cast Si crystals (p-type; B doped) annealed at 800°C are studied by EBIC technique\(^2\). The specimen quenched from 800°C shows dark contrasts along dislocations. On the other hand, the specimen slowly cooled from 800°C does not show such contrast around dislocations at room temperature. However, it shows the similar contrast as in the quenched specimen below 120K. On the assumption that recombination occurs via one shallow acceptor level and the hole occupation probability of which is proportional to the recombination efficiency, the energy levels of the recombination centers are determined to be \(E_V + 0.38\text{eV}\) and \(E_V + 0.11\text{eV}\) for the quenched and the slowly cooled specimens, respectively, from the analysis of the temperature dependence of the contrast pattern. They correspond to the levels of Fe interstitials and Fe-B pair, respectively.