1. Introduction  Concentrator multi-junction solar cells are paid attention as high-efficiency solar cells [1]. However, the actual efficiency under the concentrated light irradiation is lower than the theoretical value. This is considered to be due to a reduction of the open-circuit voltage followed by the temperature rise of the solar cells under operation. However, little attention has been given to a decrease of the carrier mobility under the concentrated light irradiation. In this study, we carried out the Hall measurement of n- and p-type Si samples which have different doping concentration under the concentrated light irradiation with keeping temperature. We then discussed the effect of concentrated light irradiation on the Hall mobility.

2. Experimental procedure  Four n- and p-type Si samples grown by the CZ method with different doping concentration were prepared. Before Hall measurements, an aluminum was deposited in a vacuum as electrodes. The solar simulator with a high power Xenon lamp was used as a light source. In the present study, the sunlight concentration was changed from 0.0 to 4.0 suns. To prevent an effect of the temperature increase by the concentrated light irradiation, all measurements were carried out at constant temperature of 300 K using a closed cycle refrigerator.

3. Results and discussion  Figure 1 shows the sunlight concentration dependences of the Hall mobility of all samples at 300 K. All mobilities decreased linearly with increasing the sunlight concentration. Since the sample temperature was kept constant during the measurements, the lattice scattering did not affect the Hall mobility. In addition, an infection of the ionization impurity scattering did not have an effect on the Hall mobility because the ionization ratios of the impurity level in the dark at 300 K was almost 100% for all samples. It was also found that a decrement of mobility depended on the doping concentration of sample. The Hall mobility for each samples under the concentrated light irradiation was calculated from the following,

\[ \mu_H = \frac{\Delta n \mu_h^2 - (n + \Delta n) \mu_e^2}{\Delta n \mu_h + (n + \Delta n) \mu_e} \]

where \( \Delta n \) is the photo-generated carrier concentration of n-Si, \( \mu_h \) and \( \mu_e \) are the mobility of hole and electron [2], \( n \) is the doping concentration of n-Si, respectively. The formula of p-type was deformed as well. When the doping concentration was high, it was found that an effect of the concentrated light irradiation on the Hall mobility was small. This was observed in both n- and p-type samples.

4. Conclusion  The Hall mobility decreased linearly with increasing the sunlight concentration. It was also found that these decrease of Hall mobility under the concentrated light irradiation could prevent by using a sample with high doping concentration. However, high doping concentration will cause a decrease in minority carrier lifetime followed by the Auger recombination. A more comprehensive analysis is needed to improve the conversion efficiency under the concentrated light irradiation.

Acknowledgements  A part of this study was supported by Grants-and-Aid for Scientific Research (B) 16H04648 under the Ministry of Education, Culture, Sports, Science, and Technology, Japan.

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