Preferred type of presentation:
Poster

Title:
Mechanisms of Changes of Hole Concentration in Al-doped 6H-SiC by Electron Irradiation and Annealing

Body:

SiC is a promising wide band gap semiconductor for fabricating high-power and high-frequency electronic devices capable of operating under radiation environments, because the minority-carrier-lifetime degradation by irradiation in SiC was reported to be lower than in Si and GaAs [1]. Compared with Si [2], however, the understanding of radiation damage in SiC is far from complete [3].

According to our simulation [4], irradiation with 200 keV electrons can replace only substitutional C atoms in SiC, while irradiation with 100 keV electrons cannot. Moreover, electrons with $\geq$ 400 keV can replace all atoms in SiC.

The temperature dependence of hole concentration p(T) in Al-doped 6H-SiC epilayers was obtained by Hall-effect measurements, from which the densities and energy levels of acceptors were determined. Before irradiation, the density of acceptors (N_{A1}) at E_V+0.24 eV in the epilayer was determined to be 1.6×10^{15} cm^{-3}, and the density of acceptors (N_{A2}) at E_V+0.4 eV was 1.0×10^{15} cm^{-3}.

Irradiation with 200 keV electrons reduced p(T). After irradiation with a 1×10^{16} cm^{-2} fluence, N_{A1} decreased to 6.0×10^{14} cm^{-3}, while N_{A2} increased to 2.2×10^{15} cm^{-3}. After second irradiation with the same fluence, N_{A1} decreased to < 10^{14} cm^{-3}, whereas N_{A2} remained. Third irradiation resulted in incapable measurement due to too high resistivity of the irradiated epilayer. After 500 ˚C annealing for 2 min in Ar, however, N_{A1} increased to 4.0×10^{14} cm^{-3} and N_{A2} decreased to 1.6×10^{15} cm^{-3}, compared with the second irradiation. This is an unexpected phenomenon.

First irradiation with a 1×10^{16} cm^{-2} fluence of 100 keV electrons did not change p(T). However, second irradiation with a 2×10^{16} cm^{-2} fluence increased p(T) at low temperatures, which is also an unexpected phenomenon.

Possible mechanisms of changes of p(T) by electron irradiation and annealing will be discussed.

[1] A.L. Barry, et al., IEEE Trans. Nucl. Sci. 38, 1111 (1991)
[2] H. Matsuura, et al., Jpn. J. Appl. Phys. 45, 2648 (2006)
[3] H. Matsuura, et al., J. Appl. Phys. 104, 043702 (2008)
[4] H. Matsuura, et al., Physica B 376-377, 342 (2006)

Section:

Corresponding e-mail:
matsuura@isc.osakac.ac.jp

Keywords:
Radiation damage, Electron irradiation, SiC, 6H-SiC, p-type SiC

Names;
Hideharu Matsuura, Hideki Yanagisawa, Kozo Nishino, Yoshiko Myojin, Takunori Nojiri, Yukei Matsuyama, and Takeshi Ohshima

Organization:
Department of Electronic Engineering and Computer Science,
Osaka Electro-Communication University, 18-8 Hatsu-cho, Neyagawa, Osaka 572-8530, Japan

Japan Atomic Energy Agency, 1233 Watanuki, Takasaki, Gunma 370-1292, Japan