DLTS and Photoluminescence Analysis of Intentionally B-doped 4H-SiC Epilayers

電中研 [1], 産総研 [2], 富士電機 [3] ○楊 安麗 [1], 宮澤 哲哉 [1], 俵 武志 [2,3], 土田 秀一 [1]
CRIEPI [1], AIST [2], Fuji Electric Co., Ltd.[3], ○A. Yang[1], T. Miyazawa[1], T. Tawara[2,3], H. Tsuchida[1]
E-mail: yang-al@criepi.denken.or.jp

The D center and other deep levels in B-doped 4H-SiC epilayers were investigated by deep level transient spectroscopy (DLTS), minority carrier transient spectroscopy (MCTS) and photoluminescence (PL) measurements. The samples were intentionally B-doped (using tri-ethyl-boron (TEB) as the B source) *p*-type and N+B doped *n*-type 4H–SiC (0001) epilayers grown by CVD. Three hole traps, namely D center (E_V+0.58~0.68 eV), HK2 (E_V+0.84 eV) and HK3 (E_V+1.23 eV) were detected in the *p*-type samples through DLTS. The D center concentration was found to increase almost linearly with B doping concentration from 3.9×10^{15} to 6.4×10^{16} cm^{-3} (measured by SIMS) as shown in Fig. 1. The MCTS results for the low N+B doped *n*-type samples indicated that the D center concentration reduced from 9.0×10^{12} cm^{-3} to the detection limit after thermal oxidation. These results are consistent with the D center being a complex consisting of a B atom with an adjacent C vacancy (V_C) [1]. The D center concentration reached the 10^{15} cm^{-3} level, which is more than two orders higher than typical V_C concentrations for the epilayers grown without intentional B doping. This implies that the V_C defects consisting of the D center have been formed by the introduction of B. Figure 2 shows the PL spectra of an N (8.6×10^{18} cm^{-3}) + B (2.8×10^{17} cm^{-3}) doped 4H-SiC epilayer at 10 K and at room temperature (RT). At 10 K, the many small peaks with regular energy separations observed on a broad luminescence signal (1.9-2.6 eV) indicate phonon assisted donor-acceptor pairs (DAP) recombination. At RT, the DAP luminescence reduced and the free-to-bound luminescence grew, showing the smoothing of the spectrum curve and a blue-shift of the center of the PL spectra. No band-edge luminescence was observed in this N+B doped sample, indicating that band to band recombination was effectively prohibited by the B doping.

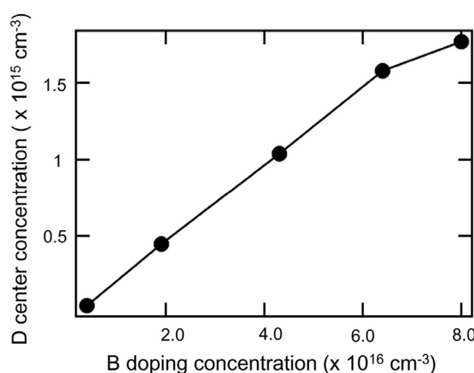

Fig.1. Relationship between D center and B doping concentrations.

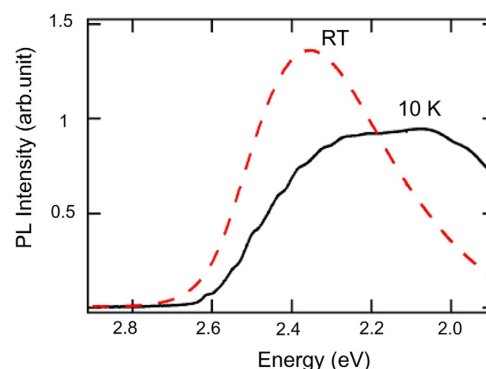

Fig.2. PL spectra of N+B doped 4H-SiC at 10 K (black line) and RT (red dash line).

Acknowledgements. This work was supported by Council for Science, Technology and Innovation (CSTI), Cross-ministerial Strategic Innovation Promotion Program (SIP), "Next-generation power electronics/Consistent R&D of next-generation SiC power electronics" (funding agency: NEDO).

[1] A. Duijn-Arnold, et al., Phys. Rev. B 57, 1607 (1998).

© 2016年 応用物理学会