50μm 4H-SiC トレンチの CVD 埋戻し成長の検討

A study of the CVD growth condition for filling 50-μm 4H-SiC deep trench

産総研[1], 三菱電機[2], 富士電機㈱[3], 日立製作所[4] ○紀世陽[1], 小杉亮治[1], 児島一聡[1], 足立亘平[1,2], 河田泰之[1,3], 望月和浩[1,4], 長田晃代[1], 松川康子[1], 米澤喜幸[1], 吉田貞史[1], 奥村元[1]

AIST[1],Mitsubishi Electric[2],Fuji Electric[3],Hitachi Ltd.[4] ○S.Y.Ji[1], R.Kosugi[1], K.Kojima[1], K.Adachi[1,2], Y.Kawada[1,3], K.Mochizuki[1,4], Y. Nagata[1], Y.Matsukawa[1], Y.Yonezawa[1], S.Yoshida[1], H.Okumura[1]

E-mail: aist-ki@aist.go.jp

Super-junction structure (SJ) has been commercially applied on Si-based power devices, due to the improvement on the trade-off relation between the blocking voltage (V_B) and the specific on-resistance (R_{onA}). As for SiC material, the superior performance of using SJ structure has been experimentally demonstrated by the multi-epitaxial growth method [1]. In addition, the high productivity and the epitaxial trench filling by chemical vapor deposition (CVD) has been confirmed feasible to construct SJ consisting of narrow and deep p/n column structure with a depth of 25 μm [2]. It is well known that, for devices working at higher blocking voltages, a much deeper p/n columns structure is necessary to achieve a high device performance. In this work, we specified the problem found in the CVD filling process of 4H-SiC deep trenches and tried to explore a growth condition which is possible to fill the trenches up to 50 μm.

Figure 1 shows the typical SEM images of filled 25-μm and 50-μm-level 4H-SiC trenches on the same conditions [2]. On mesa top, the epilayers are in a similar thickness for each type of trenches. However on trench bottom, the results are quite different; in Fig. 1(a), the trench has been completely filled at a filling rate (R_{G_TB}) of ~4.2 μm/h, whereas it shows a small value of R_{G_TB}~1.5 μm/h in Fig. 1(b), corresponding to an extremely long complete-fill-duration, *i.e.*, nearly 40 hours. In our experience, besides the widened trench pitch (from 5 to 20 μm), the doubled diffusion distance (from 23 to 55 μm) caused a reduced amount of source species that arriving at trench bottom is thought to be the main reason. To solve the problem of low filling rate, we propose that, performing the condition showing high partial pressures of source species together with the optimization of C/Si ratio, growth pressure and HCl flow rate are feasible to fill 50-μm-level 4H-SiC trench. Detailed experiment and discussions will be presented at the meeting.

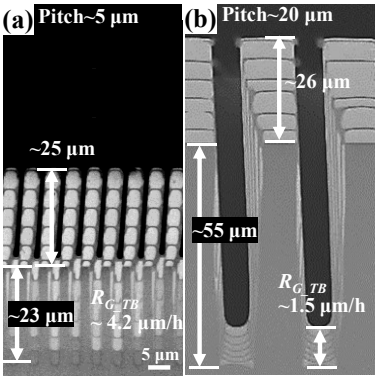

Fig.1 SEM images of filled trenches after 6 hr growth. Dark-line represents the N_2-mark layer for each hour.

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] R. Kosugi *et al*. Proc. Int. Sym. Power Semiconductor Devices and IC's (ISPSD), (2014) 346.

[2] S.Y. Ji *et al*. Appl. Phys. Express 10 (2017) 055505.