# 4H-SiC PN コラムの濃度プロファイルの改善

## To construct 4H-SiC p/n columns with relatively uniform doping profiles

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In order to improve the trade-off relation between the blocking voltage and the specific on-resistance, the super-junction (SJ) with alternative p/n columns structure, has been developed and applied on power devices. On SiC-SJ, its superior properties have been confirmed on devices formed by the multi-epitaxial growth method and the trench filling epitaxial growth method (TFEG) using a chemical vapor deposition (CVD) system [1-3]. However, the doping level distribution has been found non-uniform on the epilayer inside trench, where an area of high Al-doping level around the central trench can be detected along the growth direction [4]. From our experiences, comparing with using Al, CVD growth using $N_2$ as the dopant seems showing a weak dependence of doping level alteration against the crystalline planes and the applied C/Si ratios. In this work, we tried to construct relatively uniform doping profiles on both sides of p/n columns, by filling n-type epilayer to a pre-formed p-type trench using TFEG method.

P-type trenches were formed on a 10-µm-thick 4H-SiC epilayer on n+ substrate along [11-20] with the line and space of 2.5 µm. Scanning electron microscopy (SEM) and scanning non-linear dielectric microscope (SNDM) were used to characterize the filled trenches. Figure 1(a) and (a') are the previous report on filling p-type epilayer to a pre-formed n-type trench. SNDM shows a bright area (high acceptor density, high Al-doping level) in trench center, which reveals a non-uniform distribution of incorporated Al impurities. Figure 1(b) and (b') are results on filling n-type epilayer to a pre-formed p-type trench. Both the SEM and SNDM display rather mild contrast (low variation on doping level) around center and p/n interfacial areas. Calibration using a reference sample allows the estimation and quantitation of the incorporated N and Al of the filled trench in Fig.1(b). It demonstrates an improvement on the uniformities of doping level on p/n columns. Detailed experiment and discussions will be presented at the meeting.

[1] R. Kosugi *et al*. ISPSD, (2014) 346.　　　[3] S.Y. Ji *et al*. J.Cryst.Growth, 546 (2020) 125809.

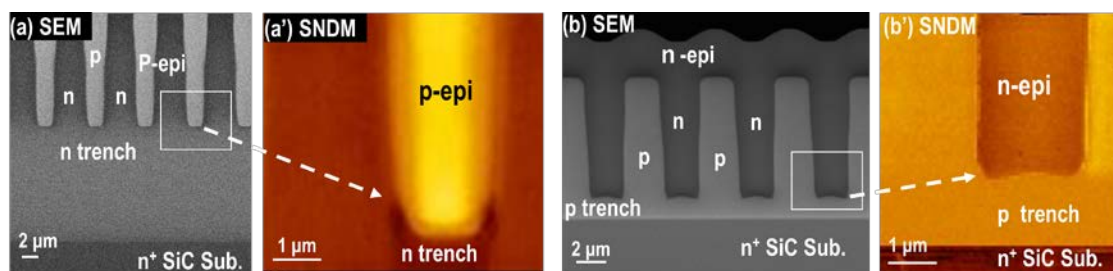[2] R. Kosugi *et al*. ISPSD, (2019) 39.　　　[4]山田敬一,応物春季講演会 (2017)7a-A201-7.

Fig.1 SEM images of filled trenches and the corresponding SNDM profiles on (a)(a') for p-epilayer to n-trench [4], and (b)(b') for n-epilayer to p-trench, both on a commercial n+ 4H-SiC substrate.