Study of surface defects in 4H-SiC Schottky diodes using a scanning Kelvin probe

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In presented earlier paper \cite{1} were investigated the leakage currents in commercial 4H-SiC Schottky diodes with an integrated p-n-structure. To substantiate the statistics were examined ~ 140 structures. As expected the variation in magnitude of leakage currents were very large - from 10 nA to 6 µA. Fig. 1 shows the typical reverse current-voltage characteristics measured at room temperature for the three chips of the total sampling. On the basis of many previous studies (e.g. \cite{2, 3}) it was suggested that the main reason for such a large difference in leakage currents are the dislocations penetrating the epitaxial layer.

To confirm this hypothesis, we selected two chips, which are very different for the leakage current (in Fig. 1 the chips 1 and 3). The metallization was removed from the surface of the chips by etching. Then by a scanning Kelvin probe (vibrating capacitor) \cite{4, 5} were obtained the local variations of surface contact potential (CPD) difference (Fig. 2).

As seen in Fig. 2 the CPD maps obtained under equilibrium and nonequilibrium conditions, as well as the differential map evidently are different for the samples.

Calculated surface potential barrier for chips 3 and 1, respectively, was -400-450 mV and -500-700 mV.

Then, by etching in molten alkali on the surface of the chips was revealed the dislocation pattern. Using Nomarski microscope was evaluated the distribution of dislocation density on the surface of the investigated chips and was determined correlation between the dislocation density and potential distribution maps.

References
\begin{thebibliography}{9}
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Fig. 1. Reverse current-voltage characteristic for the three diode chips at room temperature.  
Chip 1 4300 nA @ 1400 V  
Chip 2 360 nA @ 1400 V  
Chip 3 15 nA @ 1400 V  

Fig. 2. CPD values of the samples (a) in equilibrium (dark), (b) in nonequilibrium (light) and (c) the surface photovoltage map (difference of the previous pictures, dark-light values).