Investigation on the mechanisms of nitrogen shallow implantation influence on trap properties of SiO_2/n-type 4H SiC interface*

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Silicon carbide (SiC) is the only wide-bandgap semiconductor capable of forming native dielectric layer of SiO_2 by thermal oxidation. This unique property of SiC combined with its high thermal conductivity and high critical field make this semiconductor material suitable for high power electronic devices [1-2]. Unfortunately, the state-of-the art technology does not use the full benefits of the material, especially in the case of MOSFET transistors. This is caused by inadequate electrical parameters of SiO_2/SiC interface. Two-component structure of the material and its high density results in a high level of interface traps reducing the surface mobility and thus increasing series resistance of the device [3-6]. One of the proposed methods of reducing the trap density in SiC MOS structure is a shallow nitrogen implantation prior to oxidation. This technique is based on the observation that introducing nitrogen into the SiO_2/SiC system results in significant reduction of trap states density and increase of the MOS FET effective mobility. The shallow implantation technique has been reported to be as much effective as nitric oxide annealing which is one of the most effective techniques for oxide quality improvement in case of SiC [7-9]. Unlike the diffusion based techniques, like postoxidation annealing, implantation of the nitrogen prior oxidation has the possibility of nitrogen concentration control near the oxide interface during oxidation process itself. This property is important since it was shown that the improvement degree is directly proportional to amount of nitrogen built in the vicinity of SiO_2/SiC interface during oxidation [10-11]. However previous investigations about this technique [12-16] ware inconclusive about the influence of implantation parameters and process conditions on observed effects. Both improvement and deterioration of interface quality was observed by different researchers. This behavior was never explained. The primary objective of this research is to analyze the impact of implantation conditions on electrical properties of SiO_2/SiC MOS structure based on authors own experimental results described in [7] and results reported by other researchers. This analysis is used to evaluate a hypothetical description of physical phenomena's present during oxidation of shallowly implanted substrates.

References

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