SiO_2 films on 4H-SiC: reducing interface electrical degradation due to thermal oxidation

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Silicon Carbide (SiC) is an alternative semiconductor to substitute silicon (Si) in device applications that require high-power, high-frequency, and/or high-temperature. In addition, a SiO_2 film can be thermally grown on SiC in a similar way to that on Si, allowing the technology used to produce Si MOS (metal-oxide-semiconductor) devices to be adapted to the case of SiC [1]. However, the oxidation of SiC leads to a higher interface state density in the SiO_2/SiC interface, as compared to SiO_2/Si. Such interfacial defects were indicated as the main causes of the low channel mobilities of SiC transistors [2]. A better understanding of the thermal oxidation of SiC should lead to answers on how to thermally grow SiO_2 layers minimizing the interface electrical degradation. Concerning oxidation parameters, it is already known that longer oxidation times lead to a larger electrical degradation of the SiO_2/SiC structure [3]. In this work, we present an attempt to minimize the electrical degradation in the SiO_2/SiC interfacial region by oxidizing SiC substrates in a minimal oxidation time, using $^{18}O_2$, aiming to form stoichiometric SiO_2 on SiC. X-ray photoelectron spectroscopy (XPS) was used to monitor the formation of this stoichiometric SiO_2 film. To obtain a thicker oxide film, a SiO_2 layer was deposited by sputtering as a further step. The formed structure presented improved properties compared to deposited and to thermally grown SiO_2 films on SiC. Effects of a post-deposition annealing (PDA) in Ar as an attempt to improve the quality of the formed structures were also investigated. Capacitance-voltage and current-voltage measurements in Al/SiO_2/4H-SiC MOS structures were performed to investigate the electrical properties. Amounts and distribution of ^{18}O in the samples were determined by nuclear reaction analyses and related to the electrical modifications induced by the PDA in Ar and will be also presented.

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