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Physical Characteristics of Sol-gel Derived SiO_2 Thick Film on 4H-SiC

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The excellent properties of SiC have led to the usage of this material as a substrate for high power, high temperature, and high frequency metal-oxide-semiconductor (MOS)-based device applications [1,2,3]. Thermally grown nitrided SiO_2 has been identified and proven to be the choice of gate oxide in those devices due to its high quality. However, this is a high thermal budget and time consuming oxide growing process. It is extremely difficult to grow a thick oxide (>100 nm) using this method. Therefore, sol-gel spin-on coating has been used to overcome these issues. In this paper, we have investigated the physical properties of sol-gel derived SiO_2 thick film on n-type 4H-SiC.

N-type, 8^o off (0001) oriented, 4H–SiC wafers were used to fabricate the MOS-capacitor test structures. The wafers were spin-coated with sol-gel precursor at 5000 rpm for 90 seconds after underwent a standard wafer cleaning process. The samples were then annealed in argon gas ambient at 650°C, 750°C, 850°C, and 950°C respectively for 30 minutes. After cooling down to room temperature, the samples were ready for physical characterization. The obtained oxide thickness was in the range of 100 nm to 130 nm.

The relationship among porosity percentage, dielectric constant, and refractive index as a function of annealing temperature are presented in Fig. 1. It is obvious that the oxide is denser with a significant reduction in percentage of porosity as the annealing temperature increases, except for sample annealed at 950°C. The reason for this observation will be explained in the full manuscript. Figure 2 presents the results of root-mean-square (RMS) roughness, measured by an atomic force microscope, of the oxide surface and crystallite size calculated based on SiO_2 diffraction peak of a x-ray diffraction measurement. An increase of both parameters has been revealed as the annealing temperature increases from 650^oC to 850^oC. However, these parameters are reduced when the sample is annealed beyond 850^oC. This may be due to viscous shear flow effect of the SiO_2. The detail discussion on this effect will be elaborated in the full manuscript.

Acknowledgement
One of the authors (KYC) would like to acknowledge the financial support of this work from the Ministry of Science, Technology, and Innovation (MOSTI) of Malaysia, through ScienceFund Research Grant (Grant number: 6013304).

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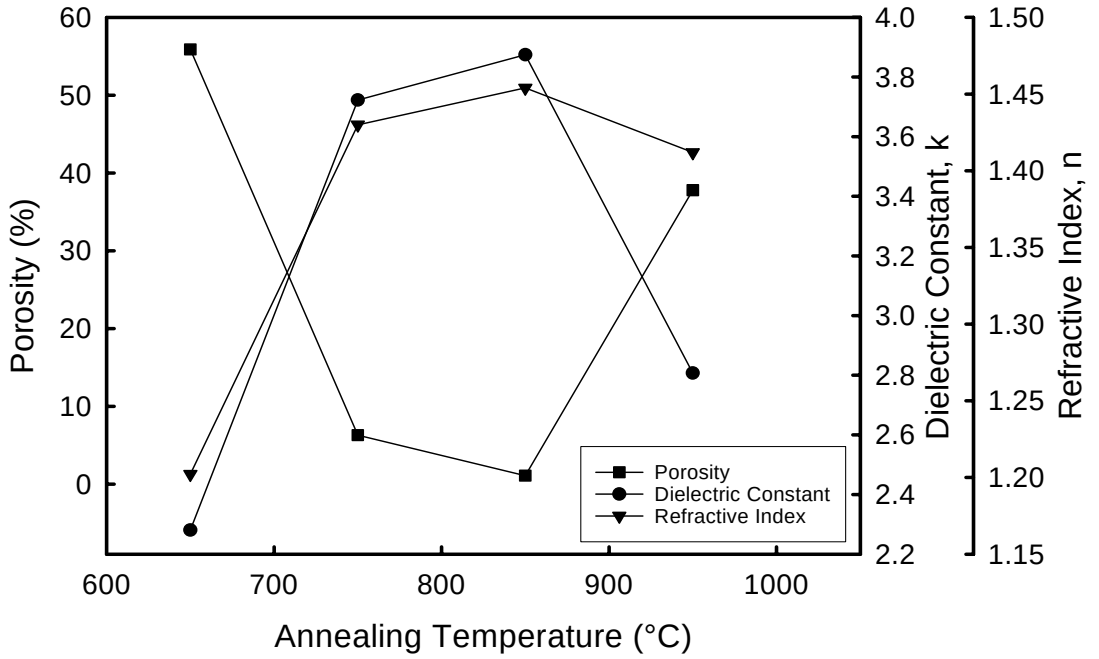

Figure 1: Relationship among porosity percentage, dielectric constant, and refractive index as a function of annealing temperature

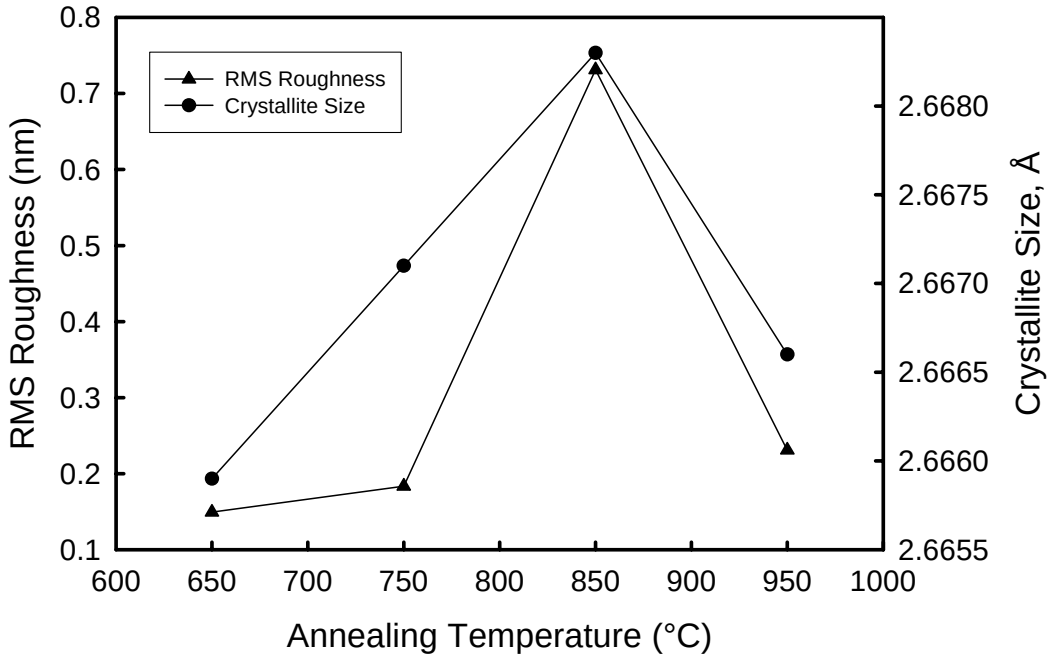

Figure 2: Root-mean-square (RMS) roughness and crystallite size as a function of annealing temperature.