Stress distribution at SiO_2/4H-SiC interface studied by Confocal Raman Microscopy

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Silicon carbide is a promising material for power devices due to excellent physical and electrical properties. However, SiC metal-oxide-semiconductor field effect transistors (MOSFETs) have suffered from the low channel mobility due to high defect density at SiO_2/SiC interfaces. The induced stress at SiO_2/SiC interface during the thermal oxidation of SiC is one of the reasons of the defect formation [1]. It has been claimed that post-oxidation annealing (POA) methods, such as annealing in NO, are effective in passivation of interface defects [2]. However, its underlying physics remains unclear. In this work, we investigated the stress distribution at SiO_2/SiC interface by using a confocal raman microscopy technique.

Dry oxidation of 4H-SiC (0001) at 1200℃ was performed to grow 50 nm thick SiO_2 films. Then, a post-annealing in NO ambient at 1250℃ was carried out for 0, 10, 60, 120 min. The SiO_2 films were chemically etched by HF aqueous solution. Then, confocal raman spectroscopy measurements were performed for the HF treated samples using 532nm laser with 10 mW power and 100x objective lens with numerical aperture 0.95 to characterize the stress distribution at SiO_2/SiC interface. The dependence of Raman peak shift on SiO_2 residual thickness is summarized in Fig.1. The peak shift indicating stress generation was observed for the sample with residual SiO_2 thickness of above 20 nm. This result agrees with the stress distribution reported at Ref. 3. The stress σ based on the biggest peak shift δ was calculated by $\sigma = \delta/\{-2a(S11+S12)-2bS13\}$ [4], where a and b are constants, S11, S12 and S13 are the elastic compliance constants at RT. The relationship between calculated stress σ and NO annealed time are shown in Fig 2. Since the calculated stress have similar values, we cannot find clear evidences that NO post-annealing has an effect in relaxation of stress at SiO_2/SiC interface.

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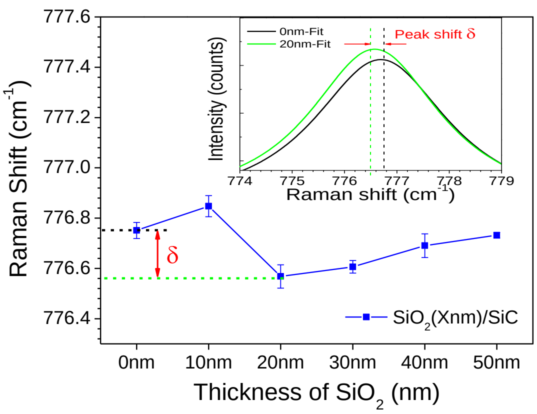

Fig 1 The dependence of Raman peak shift on SiO2 residual thickness, measured by using NA0.95 lens. Inset shows the raw peak position of Raman measurement.

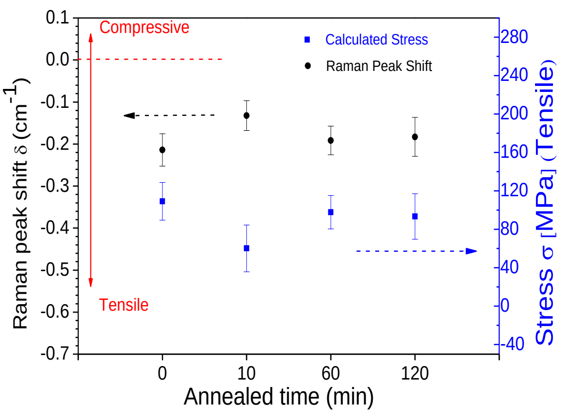

Fig 2 Comparison of the stress at interface of samples were performed post-oxidation annealing for 0, 10, 60, 120min in NO ambient.

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