

GeO₂/Ge からの GeO 脱離と GeO₂ の結晶化の関係

Crystallization of GeO₂ on Ge is really triggered by GeO desorption?

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Because of structural similarity with SiO₂, GeO₂ has been often regarded as the best dielectric film on Ge. It is, however, well-known that GeO₂ is water-solvable and GeO desorption is easily desorbed from GeO₂/Ge stack [1]. GeO₂ crystallization on Ge after GeO desorption has also been experimentally demonstrated [2]. It is intuitively expected that GeO₂ crystallization may be triggered by GeO desorption, but it is not clearly understood whether it is true or not. This paper reports that GeO desorption is NOT directly related to GeO₂ crystallization.

GeO₂/Ge stack with thick SiO₂ cap layer was prepared. **Figure 1** shows the GeO desorption from 270 nm GeO₂/Ge stack in TDS. GeO desorption signal is detected from the stack w/o cap layer, while not observable from w/ cap layer within our experimental accuracy. Then, these samples were inspected by XRD. **Figure 2** shows the crystallization of both stacks, which is like α -quartz type structure.

The results clearly indicate that GeO₂ crystallization is NOT caused by GeO desorption from GeO₂/Ge stack. As we have already discussed [2], the reaction between GeO₂ and Ge is one of the oxidation mechanisms even in UHV, it may progress in capped GeO₂/Ge. Resultantly, oxygen-deficient GeO₂ may be formed, and easily crystallized.

This result strongly suggests that GeO₂/Ge gate stack has intrinsically weak against external perturbation, including electrical stress, as reported experimentally [3]. Apparently good characteristics in the initial properties are not enough but stable network should be carefully considered in terms of the device reliability [4].

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Ref: [1] S. K. Wang et al., JAP 108, 054104 (2010). [2] X. Wang et al., APL 111, 052101 (2017). [3] X. Tang et al., SSDM 2017. [4] T. Nishimura et al., IEEE JEDS 6, 1212 (2018).

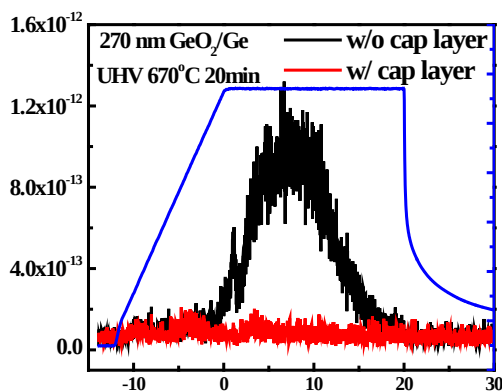


Figure 1 TDS spectra of GeO desorption from 270 nm GeO₂/Ge w/ and w/o cap layer in UHV at 670°C for 20 min.

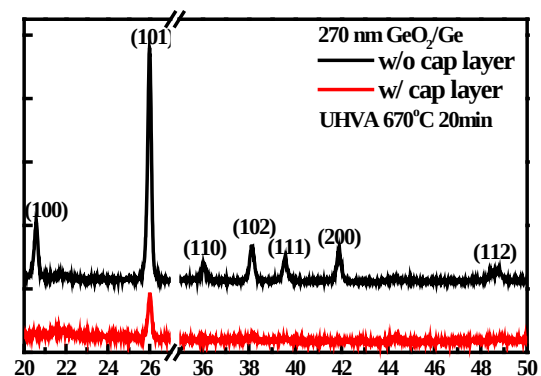


Figure 2 XRD of 270 nm GeO₂/Ge w/ and w/o cap layer after anneal in UHV at 670°C for 20 min.