One Element of Leakage Current of Insulator

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Motivation

The authors previously evaluated the electrical characteristics of some low-k materials[1] that had been developed and reported in various places, using P-TEOS as a reference. That evaluation revealed that the electrical characteristics of P-TEOS film depend on the condition of the film[2]. So, a more detailed investigation of the characteristics was undertaken.

Experiments

Conventional P-TEOS films deposited on 8-inch wafers (N-type) were used. Figure 1 shows the TDS for the films. After annealing for more than 100 min. at 500°C, hardly any gases desorb. Film that does not exhibit any desorption was termed “degassed P-TEOS”. The electrical characteristics of conventional and degassed P-TEOS films were measured in a vacuum probe chamber[2] (Fig. 2) using a MIS structure with aluminum electrodes.

Results and discussion

Figures 3 and 4 show the I-E characteristics[4] and the dielectric constants of conventional and degassed P-TEOS films. At higher temperatures, conventional film has a higher leakage current. The dielectric constant based on orientational polarization exhibits a temperature dependence[3], with the value for conventional P-TEOS being larger than that for degassed film. This means that conventional P-TEOS contains more moisture or O-H bonds; and the higher leakage current of conventional film suggests that it is this moisture that is responsible for the leakage current. Figure 5 shows Qmass spectra for conventional P-TEOS during BTS. The O_2 (mass number: 16) signal does not have a clear dependence on applied bias time. However, the H_2 signal does have a clear dependence; that is, when a bias is applied, the signal increases. From these results, it is clear that the leakage current at high temperatures is mainly due to moisture in the film. The most likely mechanism is that the moisture is decomposed by electrolysis during electrical measurements, producing H^+ and OH^-, which drift; and it is this flow of ions that constitutes the current in the film.

Acknowledgments

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References

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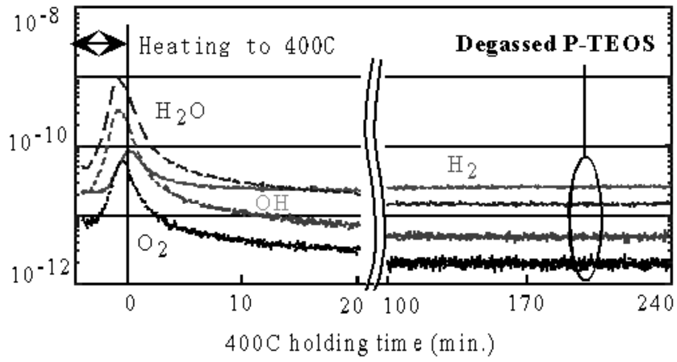

Figure 1 TDS of P-TEOS and definition of degassed P-TEOS

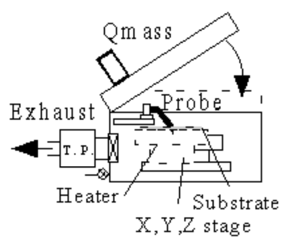

Figure 2 Vacuum probe chamber

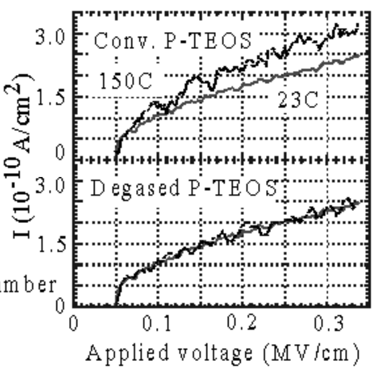

Figure 3 I-E charcteristics

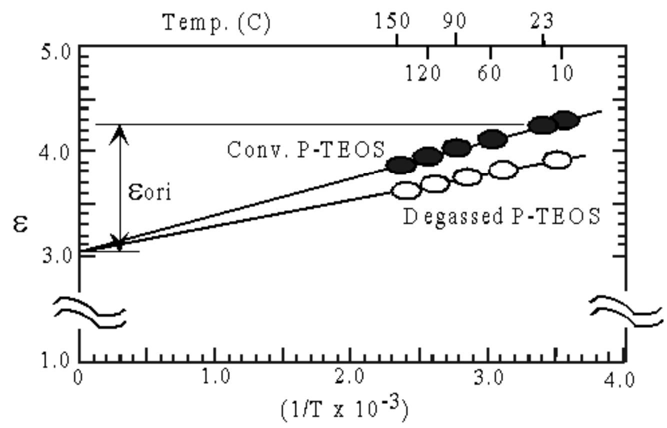

Figure 4 Temperature dependence of dielectric constant

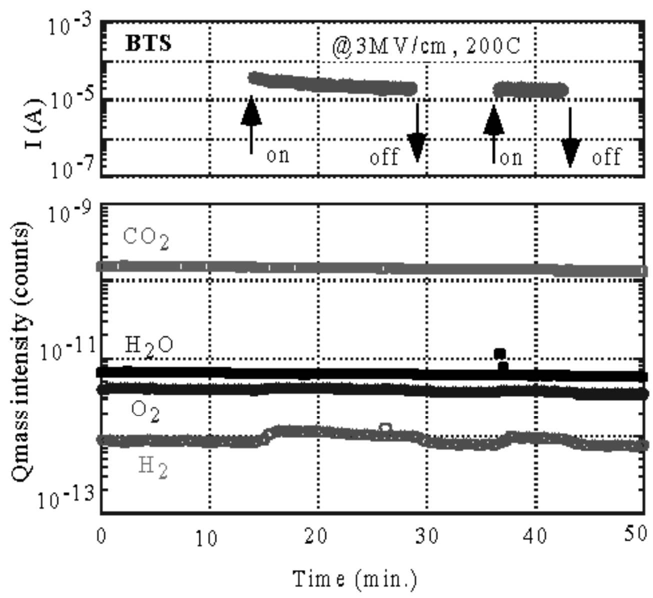

Figure 5 Qmass spectra of conv. P-TEOS in BTS