

Investigation of Reactive Ion Etching (RIE) Induced Damage Mechanism and Development in Sub-20nm PRAM Patterning

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Phase change random access memory (PRAM) is considered to be one of the most promising storage class memory candidates. The interest in PRAM is based on the fact that resistive memory guarantees superior memory performances as well as the potential for high-density and low-power applications. To compete with 3D NAND flash, 3D vertical structure is essential to PRAM. In recent days, various types of 3D X-point PRAM structures have been invented. From this viewpoint, 3D X-point technology is needs to 3D integration stack process and fine patterning method for the Ge₂Sb₂Te₅ (GST) with sub-20nm scaled size, is becoming important. In particular, it is difficult to conserve the etched sidewall composition of GST or OTS without halogenation-induced degradation and fine patterning for 10-nm-order size.

In this presentation, a dry etching method of fabricating fine phase change material patterns with sub-20nm size is provided for the realization of future PRAM, in which the use of a passivation layer, an optimum etching gas mixture, and process parameters for dry etching are specifically proposed. Also, reactive ion beam etching (R-IBE) has been studied for the sputtering etching of a pattern using a mixture of noble gas and halogen gas without using a radical species through the extraction of ion from the grid of equipment.

From these results, we discussed and proposed to mechanism of etching process in PRAM device. General reactive ion etching (RIE) method is used for the patterning process, the patterned GST and OTS material cannot maintain its original physical properties after the patterning process. Finally, we were able to obtain the damage-free GST and OTS layer using the R-IBE method, and also we achieved the same results at 40nm pitch PRAM. This kind of research and presentation can be very helpful for obtaining and developing a wide process window for the fabrication of tens-of-nanometer sized PRAM devices with uniform and reliable characteristics.

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