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Etch Characteristics of MgO Thin Films in Cl2/Ar, CH3OH/Ar, and CH4/Ar Plasmas

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Currently, the flash memory and the dynamic random access memory (DRAM) have been used in a variety of applications. However, the downsizing of devices and the increasing density of recording medias are now in progress. So there are many demands for development of new semiconductor memory for next generation. Magnetic random access memory (MRAM) is one of the prospective semiconductor memories with excellent features including non-volatility, fast access time, unlimited read/write endurance, low operating voltage, and high storage density. MRAM is composed of magnetic tunnel junction (MTJ) stack and complementary metal-oxide semiconductor (CMOS). The MTJ stack consists of various magnetic materials, metals, and a tunneling barrier layer. Recently, MgO thin films have attracted a great attention as the prominent candidates for a tunneling barrier layer in the MTJ stack instead of the conventional Al2O3 films, because it has low Gibbs energy, low dielectric constant and high tunneling magnetoresistance value. For the successful etching of high density MRAM, the etching characteristics of MgO thin films as a tunneling barrier layer should be developed. In this study, the etch characteristics of MgO thin films have been investigated in various gas mixes using an inductively coupled plasma reactive ion etching (ICPRIE). The Cl2/Ar, CH3OH/Ar, and CH4/Ar gas mix were employed to find an optimized etching gas for MgO thin film etching. TiN thin films were employed as a hard mask to increase the etch selectivity. The etch rates were obtained using surface profilometer and etch profiles were observed by using the field emission scanning electron microscopy (FESEM).

Keywords: MgO thin films, Magnetic tunnel junction, Tunneling barrier layer, Inductively coupled plasma reactive ion etching