Dry Etching of Magnetic Tunnel Junction Stacks in a CH_3COOH/Ar Gas Mixture

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Abstract: *Currently available semiconductor memory devices are primarily composed of Dynamic Random Access Memory (DRAM), Static Random Access Memory (SRAM) and flash memories, which are based on combinations of capacitors and transistors. Even though this technology in the early 1970's, successful efforts have been made to increase their storage density and decrease their prices. Nevertheless, use of these memory devices is limited owing to volatility problems and capacity restrictions. Magnetic random access memory (MRAM) offers the promise of replacing traditional memory devices such as DRAM, SRAM and flash memory. The MRAM device compared to its counterparts (DRAM, SRAM, flash memory, etc.), offers higher density, faster access time, unlimited read/write endurance and non-volatility. MRAM devices are mainly composed of a magnetic tunnel junction (MTJ) stack and CMOS. In order to achieve high storage densities in MRAM devices, the pattern transfer in magnetic layers structures that comprise the MTJ stacks is a critical step. A wide range of etching gases has been employed for the ICPRIE of CoFeB thin films such as HBr, Cl2, BCl3 etc. In general, when using halogen gases, the etch rates are extremely high; but sidewall redeposition and corrosion problems are common [1-3]. Recently, an effort to improve the etching characteristics of magnetic layers, while at the same time reducing post-etching treatment, non- corrosive etching gases such as CO/NH3, CH4, CH3OH have been researched. The use of this etching gases mixed with Ar gas had to prove yield a redeposition free anisotropic etch profile despite the low etch rates compared to halogen gas mixtures [4-6]. In this study the ICPRIE of MTJ stacks patterned with a hard mask containing an array of 90 x90 nm2 was performed using an alternative CH3COOH/Ar gas mixture. HRSEM and FETEM micrograph revealed that, compared to Ar physical sputtering, etch profiles with a high degree of anisotropy could be achieved when MTJ stacks were etched in a CH3COOH/Ar gas mixture. Additionally EDS analysis results showed negligible redeposition on the MTJ stacks sidewall and bottom electrode surface.*

Keywords: *Magnetic tunnel junction (MTJ) stacks etching; inductively coupled plasma reactive ion etching; CH3COOH vapour.*

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