

# Etch Characteristics of Ta Thin Films Using Halogen Containing Gas Mixtures in Inductively Coupled Plasma for Hard Mask Applications

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**Abstract:** *Tantalum is known to be a refractory metal which had been commonly used in microelectronic devices and also has received a great deal of attention due to its numerous application such as capping layer, electrode in STT-MRAM and X-ray absorber layer for EUVL.*

*In addition, Ta can be used as a hard mask in plasma etching in order to transfer patterns (i.e. MTJ stacks etching) and metal electrode due to its capability to withstand high temperature and strong adhesion compared to the conventional organic photoresist mask. However, very few papers describe in detail the etch profile and mechanism of Ta thin films, especially evidence of a redeposition free anisotropic etch profile is rare. Development of nano scale anisotropic etching process of Ta thin films is necessary for its future applications in MTJ stacks as a hard mask material.*

*In this paper we investigate the inductively coupled plasma reactive ion etching of Ta thin films. Etch rate and etch profile for a  $\text{Cl}_2$ ,  $\text{C}_2\text{F}_6$  and its gas mixtures), the effect of etch parameters including coil rf power, dc-bias voltage, gas pressure and gas concentration on the etch profile and etch mechanism were investigated. The etch rates were obtained using a surface profilometer (Tencor P-1) and etch profiles were observed by using a field emission scanning electron microscopy (FESEM-HITACHI 4300SE). The surface chemistry and etch mechanism were analyzed by using optical emission spectroscopy (OES-Ocean Optics Maya 2000 Pro) and XPS analysis (X-ray photoelectron spectroscopy).*

**Keywords:** *Ta thin film etching; inductively coupled plasma reactive ion etching*