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Etching characteristics of Ta and TaN using Cl2/Ar inductively coupled plasma

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EUVL (extreme ultra-violet lithography) technology poses many new challenges on mask manufacturing processes. One crucial manufacturing step is the patterning of the absorber layers such as Cr, Ta and TaN. Etch rate and selectivity to a positive photoresist and SiO_2 under-layer were measured by varying the process parameters such as Cl_2/Ar gas mixing ratio, the top electrode power, and the bottom electrode power. To understand the etching mechanism of Ta and TaN using Cl_2/Ar inductively coupled plasma, the relative change in the emission intensities of the species in the plasma was measured by OES as a function of Cl_2 percentage in Cl_2/Ar. XPS was used to investigate the chemical states of the etched surface with various $Cl_2/(Ar+Cl_2)$ mixing ratios. The combined results suggest that Cl radicals play an important role in determining the etch rate of Ta and TaN, in which the density of Cl radicals is greatly affected by the percentage of Ar in the etch gas. As the Cl_2 flow ratio is increased, SiO_2 etching rate increases, reaches a maximum and then starts to decrease. Etch selectivity of Ta/SiO_2 and TaN/SiO_2 was increased with the increasing the $Cl_2/(Cl_2+Ar)$ flow ratio. Increase in the bottom electrode power generally increased the SiO_2 layer etch rate and as a result decreased the Ta and TaN etch selectivity over SiO_2 under-layer significantly.