The Effect of Photo Resist Outgassing on Dielectric Etch

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Outgassing of organic or inorganic compounds from photoresists has been a major concern in integrated circuit (IC) manufacturing. The effects of photoresist outgassing in areas like EUV lithography and ion implantation have been widely studied and reported [1]. In this paper, we discuss the effect of 365nm i-line photoresist outgassing on dielectric etch and a plasma cure process developed to address the outgassing of photoresist.

Resist outgassing is observed during the initial stages of dielectric etch and is found to have a localized influence on the etching of contacts and vias. The etch rates in sub micron size via holes were found to drop during the initial stages of etch while etch rates in the large open areas were not affected. Wafers cured with an insitu plasma cure step did not exhibit the same trend, as shown in figure 1. It is proposed that nitrogen is outgassing during etch due to the decomposition of un-exposed photoactive compound (PAC) at high wafer temperatures generated by the plasma. Nitrogen outgassing through the sides of the resist pattern is speculated to be diluting the local etchant species concentration as the etch rate was found to be dependent on the ratio of the area of hole opening and surface area of the sides of the resist pattern. Different types of resist were tested to study the effect of PAC concentration on localized outgassing and etch rates. Figure 2 shows the Resist A with a lower PAC concentration exhibits higher etch rates in the via holes than in the larger open areas. This trend is expected due to the micro loading effects caused by the mass flux limited regime in which the etch process in operated. Whereas Resist B with a higher concentration of PAC shows the opposite trend that can be explained by the outgassing of nitrogen during the decomposition of un-exposed PAC.

[1]. Stefan Hien, et.al, “Photoresist Outgassing at 157nm Exposure”, Advances in Resist Technology and Processing XVIII, SPIE Vol. 4345, (2001), and references therein.

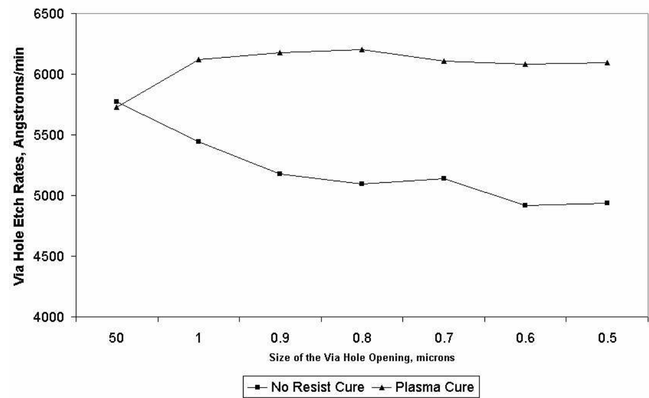

Figure 1: The etch rate difference between the large open area and sub micron via holes is reversed without a resist cure.

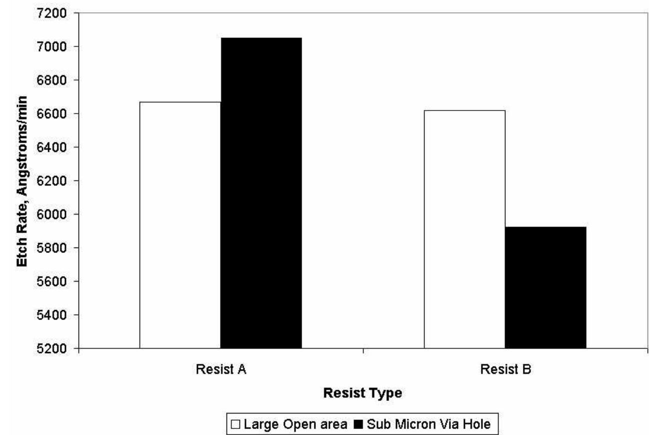

Figure 2: The Outgassing of Resist B with the higher concentration of PAC causes etch rates in the via hole to drop below that of the large open area.