Plasma Chemistry Study of Hydrogen/Oxygen mixture (H2/O2),Hydrogen Peroxide (H2O2), Water vapor (H2O), and Isopropyl alcohol (IPA) in Inductively Coupled Plasma (ICP)

Shuang Meng [1] and Shawming Ma [1]

[1]Mattson Technology, Inc., U.S.A.

Hydrogen and oxygen containing plasma has been usedextensively in photoresist strip, surface cleaning, oxidation, and surfacetreatment applications. The relative abundance and distribution of oxygen andhydrogen containing radicals generated in the plasma determines the on-waferperformance including photoresist removal rate as well as surface oxidationrate etc. In this study, we compared four different H and O containing chemistriesin ICP plasma including H2/O2 mixture, hydrogen peroxide (H2O2), water vapor(H2O), and isopropyl alcohol (IPA). The radical species and relativeconcentrations in these plasmas were determined using optical emissionspectroscopy (OES) in the range from 200nm to 800nm wavelength. Photoresiststrip rates were measured under various process conditions on Mattson's 300mmSuprema XP platform.

We found that the four chemistries (H2/O2, H2O2, H2O, andIPA) under study, although with some similarities in atomic composition,display significantly different radical concentrations in ICP plasmas. Forexample, the hydrogen/oxygen plasma exhibits strong H, O, and OH excitations inthe OES spectra, and relative intensities of these OES bands can be tuned bygas flow ratio and RF power. In comparison, the hydrogen peroxide plasmacontains less O and OH radical intensities and higher H radical intensity relativeto the 50% H2/O2 plasma. This indicates that the hydrogen peroxide (H2O2)dissociation in ICP plasma is predominantly into hydrogen (H) and hydroperoxyl(O2H) radicals rather than the naively expected hydroxyl (OH) radicals. Watervapor (H2O) plasma shows very strong OH and H bands but very weak or no O band.IPA plasma also shows absence of O band but weak CH and C2 bands in addition toH and OH bands. These differences in radical composition correspond to measureddifferences in photoresist strip property and surface oxidation property.