Cross Section of Photo Acid Generators (PAGs) in EUV Photoresists vs. Electron Beam Energies

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Optimizing the efficiency of the photochemistry in extreme ultraviolet (EUV) photoresists due to EUV exposures may enable faster, more efficient resists which would lead to greater throughput in manufacturing. Since the fundamental reaction mechanisms in the resist are due to electron interactions after an incident EUV photon generates a photoelectron during an ionization event, understanding how these photoelectrons interact with resist components is critical to optimizing the performance of EUV resists and EUV lithography as a whole. We will present measurements of the cross section of incident electron induced decomposition of three different photo acid generators (PAGs).

To study the photoelectrons generated by the EUV absorption and measure their effect within the resist, photoresists were exposed to electron beams as a function of electron energy. The reactions between PAG molecules and electrons were followed by using a mass spectrometer to monitor the levels of small molecules produced by PAG decomposition that evaporated into the gas phase. The mass spectrometer (MS) was calibrated by comparing the MS signal when films with known concentrations of PAGs were exhaustively exposed to electron beams (see figure 1). This methodology allowed us to determine the number of PAG molecules decomposed per electron. Combining this result with the average penetration depth of an electron at a given energy, the cross sections of PAGs were determined across various electron energies ranging from 50 eV to 250 eV.

The results of the measurements are cross sections of reactivity over selected incident electron energies in a PAG. Comparing the cross sections of all three PAGs and their molecular structure can provide insight into the relationship between chemical structure and reactivity to the electrons and may help in the development of new, higher efficiency EUV photoresists. This research is a part of a larger SEMATECH research program to understand the fundamentals of resist exposures to help in the development of new, better performing EUV resists.

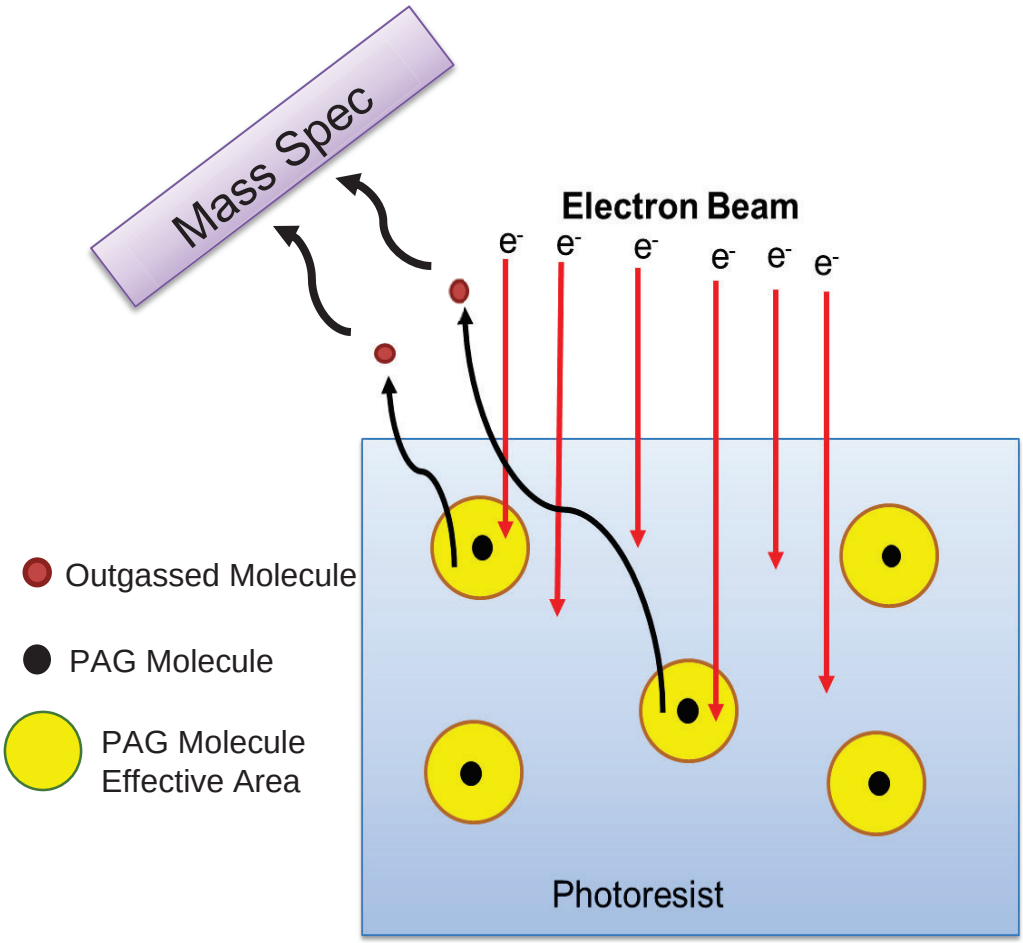

Figure 1: Top down view of a photoresist exposed under electron beam. Molecules out gassed from electron-PAG interactions are monitored using mass spectrometry. (Figure is not to scale.)