The Physics of the Exposure of Photoresists to Extreme Ultraviolet (EUV, 13.5 nm) Light
(From the Perspective of a Chemist)

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Abstract: For the past fifty years, the microelectronics industry has been on a relentless pace to improve the performance of integrated circuits by fabricating more transistors onto every chip. One key technology which has made these dramatic improvements possible has been photoresists (Figure 1A). Central to improving the resolution capability of photoresists has been the successive reduction in the wavelength of light used to expose them. Currently, the microelectronics industry is undergoing a jump in wavelength from 193 to 13.5 nm. This new wavelength is called Extreme Ultraviolet (EUV)) light. This large change in wavelength comes with a concomitant change in photon energy (6.4 to 92 eV) which creates several interesting problems for chemists and physicists to solve.

This presentation will start with a broad introduction to photoresists and EUV lithography. It then will describe how 92 eV EUV photons ionize molecules in resists, creating holes and free electrons, and identify and discuss the individual interactions that occur with atoms (Figure 1B). However, the number of electrons created, their reaction mechanisms, their lifetimes and their reaction cross-sections are not well known. The presentation will discuss experimental results and provide insight into these poorly understood aspects of EUV exposure mechanisms (Figure 1C).

Lastly, the presentation will discuss the challenges associated with the low numbers of high-energy photons that are available during exposure relative to the longer wavelength 193-nm lithography that proceeded EUV. These low numbers of photons create statistical-noise problems described as shot-noise and related to Poisson statistics. These statistics ultimately place a limit to the ultimate resolution, line-roughness, and sensitivity of this imaging technology.