Measurements of Acid Generation by EUV Irradiation in Lithographic Films

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Extreme Ultraviolet (EUV) lithography requires photoresist materials that incorporate highly efficient photoacid generators (PAGs) due to the low intensity of the currently available EUV light sources. It is therefore necessary to understand the parameters that control acid generation mechanisms in photoresists under EUV irradiation, such as photoacid generator and base quencher structure, polymer matrix effects and the interaction of ionizing radiation with the resist components. In this study, a known acid detection technique based on a dye indicator (Coumarin C6) has been optimized for the quantification of the amount of photoacid produced by irradiation of lithographic resist films. Incorporation of acid-base indicators to solid polymer matrices has already been employed in previous studies; however, the environmental stability of the reactive species and the influence of the polymer resin have not been considered to date. Here, we present a comprehensive evaluation of commercially available and newly synthesized PAGs that were exposed to 13.5 nm radiation and compared to 248 nm exposures. For some specific cases studied, it was possible to correlate the acid generation efficiency to the PAG structure and polymer matrix effects. Moreover, it is found that environmental effects such as humidity have a significant impact on acid strength, acid detection and acid generation efficiency. The acid generation efficiency experiments were complemented with dose-to-clear exposures for selected resist systems.
The obtained results indicate that the use of acid detection methods implemented for the design of EUV resist compositions with optimized photospeed requires careful attention to the complex role of the reactivity of all formulation components and photoreaction products in the presence of ionizing radiation.