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Swelling and viscoelasticity in photoresist thin films

PRAVEEN AGARWAL, The Dow Chemical Company

For a wide range of electronic applications, polymers are processed in the thin film state with the film thickness lower than 100 nm. Understanding the polymer structure property relationship at those characteristic length scales is important to enable the material design for various applications. Extreme ultraviolet lithography (EUVL) is the next generation lithographic technique using low wavelength (13.5 nm) ultraviolet radiation. Quality of the final pattern in the lithographic process depends on the performance of the photoresist polymer during multiple processing steps. Photoresist material development for the EUV lithography presents several challenges for controlling the thin film swelling, density and outgassing. In particular, it has been proposed in the literature that pattern collapse, a lithographic defect where the desired features become deformed, can be caused by the swelling of the photoresist material. In this presentation, the effect of photoresist formulation and architecture on the thin film swelling and viscoelasticity will be discussed. We find that the quencher base could have a significant effect on the swelling characteristics of the photoresist. Additionally, swelling characteristics of the photoresists with covalently bound vs. blended photoacid generator (PAG) were found to be significantly different.