Relationship between Film Thickness Loss and Polymer Deprotection for EUV and ArF Photoresists

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In this paper, we report on the relationship between film thickness loss (FTL) after post-exposure bake (PEB) and the acid-catalyzed polymer deprotection of chemically amplified resists (CARs) with chemistries for ArF and EUV lithography. In particular, we use Fourier Transform Infrared Spectroscopy (FTIR) for the evaluation of the polymer deprotection in both model resists (with known critical properties) and state-of-the-art commercial resists. Through ellipsometry, we report the linear discrepancies between deprotection and FTL.

FTL curves are easily experimentally accessible and provide valuable input for the description of acid generation and polymer deprotection kinetics for resist modeling in optical and EUV lithography. This approach assumes that the FTL is directly proportional to the protecting groups escaping from the film matrix during PEB. A linear and reciprocal relationship is commonly assumed between the film thickness loss and the deprotection of the polymer.

However, recent evidence has shown (Figure 1), that this assumption does not hold under all conditions. The residual film thickness at high dose, where the resist is completely deprotected for all cases, is clearly PEB-dependent. This observation contradicts the assumption that the FTL is linearly and reciprocally related to the polymer deprotection. For accurate modeling it is critical to understand how the CARs respond to different process conditions in terms of deprotection, especially as higher resolution lithography requires thinner films and progressive transition to advanced ArF and EUV lithography.

We aim, in this paper, to use FTIR to determine the actual deprotection of resists as a function of the exposure dose for different process conditions. The corresponding film thickness loss curves are then compared to the deprotection through dose. Any linear discrepancy observed is related back to its physical origin, by use of model resists where critical parameters are systematically varied.

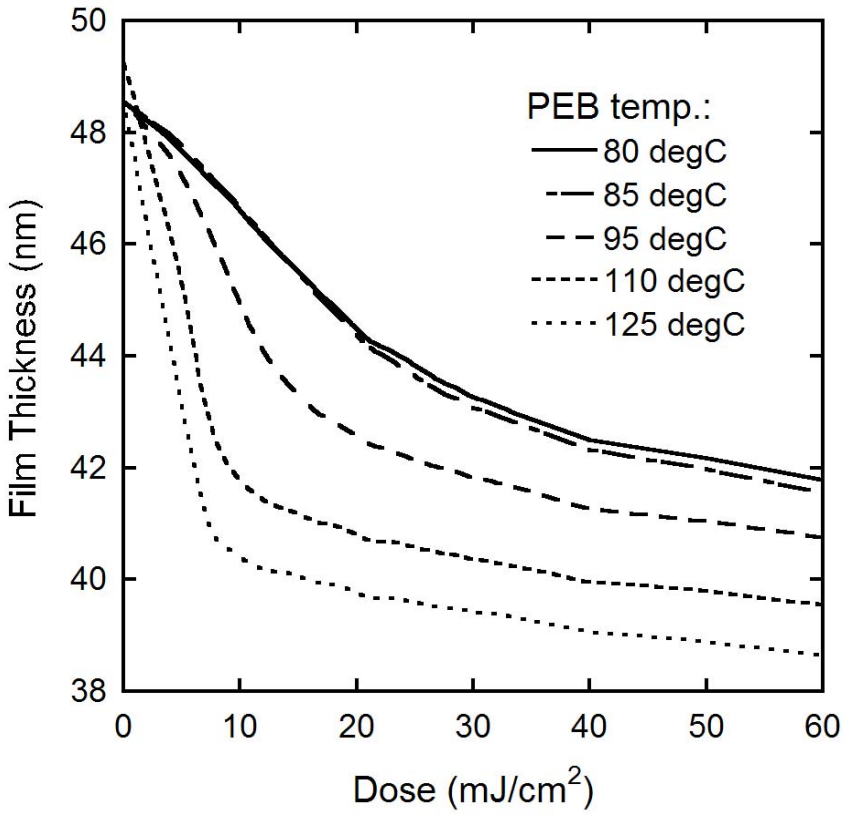

Figure 1: Film thickness loss (FTL) curves with different PEB-temperatures of a state-of-the-art commercial resist flood-exposed at EUV.