Understanding the fundamental limitations of PMMA resist for EUV exposures based on dissolution rate variations through EUV dose

Amir Hegazy and Gregory Denbeaux

EUV photoresist are a critical issue for manufacturing with EUV. Simultaneously meeting the resolution, line edge roughness and sensitivity is a challenge. One of the potential solutions is to move toward single component photoresists like the well known polymethyl methacrylate (PMMA). This could avoid the resist stochastic issues that are affecting performance of multiple component resists like the conventional chemically amplified resist platforms. Even though the overall reaction mechanism with PMMA where chain scission leads to increased dissolution rate under EUV exposure is relatively well known, we do not yet understand the fundamental limitations of this resist platform.

In order to measure the reaction process in PMMA resist exposed to EUV, we first studied how the molecular weight of the PMMA affects the dissolution rate in developer. Commercial PMMA of 50000, 495000, and 950000 molecular weights were developed in 1:1 MIBK:IPA. The dissolution rates of unexposed PMMA were determined to be 0.2 nm/s, 0.003nm/s, and 0.00013 nm/s respectively.

In this paper, we focus on studying the photon-PMMA interactions in EUV using dissolution rate as an indicator of exposure induced change in molecular weights. We exposed 950000 PMMA to series of EUV doses and studied the dissolution rates after exposures to determine the molecular weight of PMMA after chain scissioning reactions. Consequently, we were able to calculate and report the number of chain reactions per photon absorbed.