RLS Performance Tradeoffs for a Polymer Bound PAG EUV Resist

Roel Gronheid Alessandro Vaglio Pret
IMEC, Kapeldreef 75, B-3001 Leuven, Belgium

Benjamen Rathsack, Steven Scheer, Tokyo Electron America, Inc.,
2400 Grove Boulevard, Austin, TX 78741, USA

Kathleen Nafus, Hideo Shite, Junichi Kitano
Tokyo Electron Kyushu Ltd.,
1-1 Fukuhara, Koshi-shi, Kumamoto 861-1116, Japan

Keywords: EUV, lithography simulation, resolution, LWR, resist sensitivity

ABSTRACT

New resist materials and hardware processes are sought to address the resolution, LWR and sensitivity (RLS) performance tradeoffs for EUV lithography. While progress has been made on improving resolution and sensitivity, LWR continues to be a major challenge [1]. LWR has been shown to decrease as acid generation increases in the film through both experiment and simulation [2]. Acid shot noise models appear to mathematically describe the general trend between LWR and acid concentration [3,4]. These models typically assume that the initial distribution of photoacid generator in the film is random and uniform. However, our studies at ArF have indicated that PAG segregation can create a non-uniform acid profile through the thickness of a film, especially in thin films with high PAG loadings [2]. Non-uniform acid distributions have the potential to create higher roughness in areas with low acid concentration (like the resist foot). New polymer bound PAG resist systems are being designed to maintain a uniform distribution of PAG as well as control acid diffusion in the resist. These materials are likely to also affect the randomness of the PAG distrbution.

The goal of this work is to use a combination of experiment and calibrated resist models to understand the impact of PAG and sensitizer loading on the performance of a polymer bound PAG resist based processes for EUV lithography. Calibrations have been performed across imaging wavelength in order to gain confidence in the physical significance of the extracted model fit parameters (see Figure below). Model resists where PAG and sensitizer loading are systematically varied are used in order to quantitatively study these effects experimentally. Physical simulation models are created for these materials that allow to simulate the effects of loading on the chemistry and physics that is ongoing in the polymer thin films during exposure, deprotection and development.

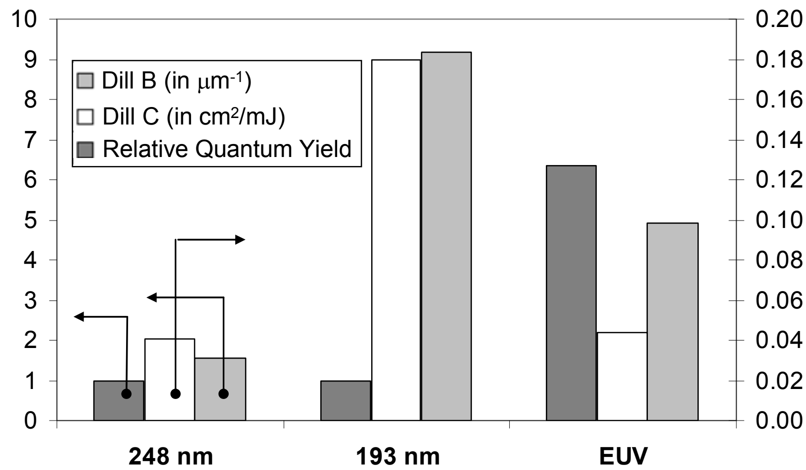

Figure. Dill B (absorbance; measured independently), Dill C (acid generation efficiency; obtained from model fit) and relative quantum yield (normalized to 1 at 248nm; calculated from Dill B and Dill C) for the resist at the three excitation wavelengths.

---

1 Putna, E. Steve, et al., "EUV lithography for 30 nm HP and beyond: Exploring resolution, sensitivity and LWR tradeoffs" Proceedings of SPIE, Vol. 7273, 2009.

2 Rathsack, Benjamen, et. al., "Resist fundamentals for resolution, LER, and sensitivity (RLS) performance tradeoffs and their relation to micro-bridging defects," Proceedings of SPIE, Vol. 7273, 2009.

3 Lawson, Richard, et. al., "Mesoscale simulation of molecular glass photoresists: effect of PAG loading and acid diffusion coefficient" Proceedings of SPIE, Vol. 6923, 2008.

4 Biafore, John, et. al., "Statistical simulation of photoresists at EUV and ArF" Proceedings of SPIE, Vol. 7273, 2009.