# Fast resist-activation dosimetry for extreme ultra-violet lithography

J.S. Heo
*Semiconductor R&D Center of Samsung Electronics, 1 Samsungjeonja-ro, Hwaseong-si, Gyeonggi-do, Republic of Korea*

M. Xu and D.J. Maas[1]
*TNO, Stieltjesweg 1, 2628 CK, Delft, the Netherlands*

Due to the rather broad band emission spectrum of the extremely hot plasma in its extreme ultra-violet (EUV) source, an EUV lithography scanner also projects out-of-band vacuum- and deep-UV (OoB V/DUV) light on the photoresist on a wafer[1]. As this kind of uncontrolled light can activate resist chemistry, it will impair the critical dimension uniformity of the patterns, especially across the borders of the fields. Hence, OoB V/DUV quantification is required in the pre-production phase. Consequently, a systematic characterization of EUV source spectrum and the spatial profile of the light as projected on the wafer is indispensable to sustain stable integrated circuit production with EUV lithography. This paper introduces the newly developed in-band EUV and OoB V/DUV dosimetry based on enhanced-energy-sensitivity by resist contrast (EESRC)[2] to understand the light distribution on the wafer in an EUVL tool, and an analysis method to quantitatively access the resist activation by in-band EUV and OoB energy distribution. This pragmatic approach can replace the current best-practice of measuring the full spectrum of an EUV light source.
In summary, this paper outlines an experimentally verified method that enables a sufficiently accurate and fast assessment of the effect of in-band EUV as well as OoB V/DUV on a photoresist. Furthermore, the method supports a swift quantification of the effect of changes to e.g. EUV mask blank design or a spectral purity filter layer on top of the resist on the dose uniformity over a full wafer under EUV (pre-)production conditions. A second application of the method is to monitor the stability of the e.g. the relevant part of the EUV light source output spectrum and the reflectivity of EUV scanner elements like projection optics, reticle mask blades and the mask[3]. Hence, it is to be expected that the EESRC method can accelerate the introduction of EUV in IC production by providing fast and accurate full-field resist activation dosimetry.

## References

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[1] diederik.maas@tno.nl

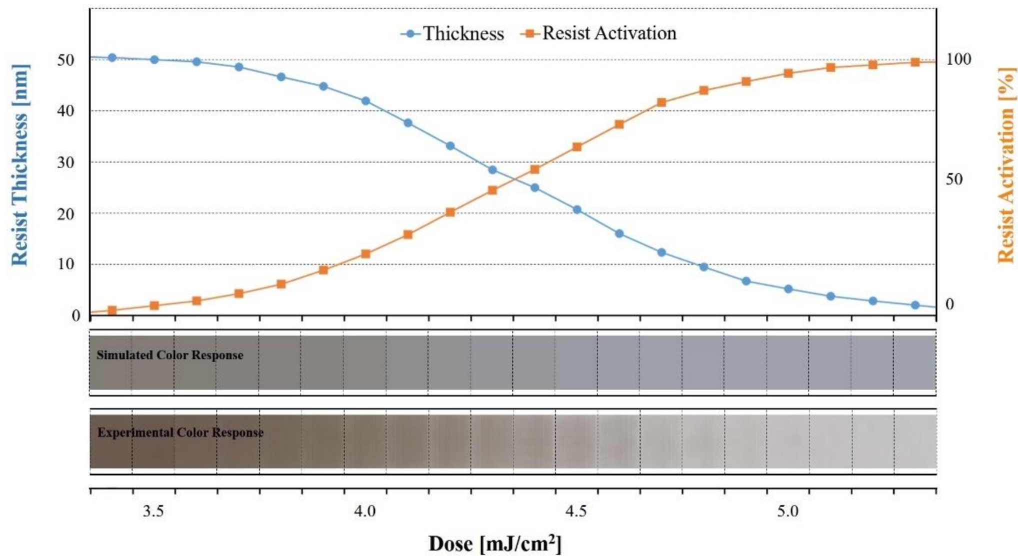


*Figure 1: Fast resist activation dosimetry for EUVL:* Top panel: resist thickness (blue dots) and the corresponding amount of resist activation (orange dots) as a function of EUV dose. Bottom panel: Experimental and simulated EESRC color-to-EUV-dose response for an uniform resist layer on a flat Si wafer. The bright bands between the experimental fields show the border effects that occur due to the exposure of the neighbor fields.

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