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Resolution, LER and Sensitivity Limitations of Photoresists

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Experimental results indicate that current resists lack the ability to simultaneously meet the goals of the 2006 International Roadmap for Semiconductors for resolution (R), line-edge/width roughness (LER/LWR), and sensitivity (S). This behavior, which we term the RLS tradeoff, has also been predicted by modeling, which again implies that it will be very difficult for a standard chemically amplified resist to simultaneously have low LER, low dose, and high resolution. The fact that the three most critical resist characteristics are currently in opposition raises serious questions about how to alter resist chemistry to make it capable of ultimately delivering the needed performance for EUV lithography.

In this work, we present an experimentally validated LER model and use it to explore the impact on the RLS tradeoff of three different properties. The first, **anisotropic acid diffusion**, alters a fundamental assumption in the original model and hence alters the RLS tradeoff. We will show how anisotropic diffusion can improve the tradeoff. The second is **increased quantum yield, Q**. Increasing Q, i.e., the number of acids generated per photon, directly improves sensitivity. We show how the various methods for increasing Q impact the deprotection distribution and hence the LER and resolution. Finally, the EUV exposure mechanism involves secondary electrons. The finite mean free path (MFP) of these electrons nominally decreases resolution, an effect that has not been accounted for in previous models. However, if these electrons can be harnessed to significantly increase Q while keeping their MFP small, it may be possible to use them to improve the RLS tradeoff.

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