193nm Photoresist Hybrids for Sub-32nm Resolution, LER, and Sensitivity Requirements

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As sub-32nm device generations are pursued, it becomes questionable whether current photoresist systems can meet lithography requirements. If resist sensitivity in the sub-50 mJ/cm^2 range continues to be specified, it will be difficult to achieve the resolution and feature quality (in terms LER and LWR) necessary for next generation device needs. As with many photochemical systems, there is a reciprocal relationship between the sensitivity and resolution of a CAR. It is well known that increases in amplification are achieved through both chemical and diffusion contributions. If both of these channels are reduced, higher resolution can be made possible. This reciprocal trade-off may be the best route toward attaining the resolution and feature quality goals. In this case, alternative or collaborative image pathways need to be explored. By making use of the current CAR material concepts and combining this with some of the historical materials systems exploration carried out for DUV and ionizing radiation, a high resolution, low LER system may be possible with the sensitivity adequate for high volume IC manufacturing.

Resists that undergo chain scission or photo-induced solubility changes have a greater potential to suppress line edge roughness because of the absence of catalytic mobility. CA resists based on acrylate copolymers possess high sensitivity, high etch resistance, high thermal stability, and base solubility but suffer from low resolution and poor LER when considered for sub-32nm application. On the other hand, scissioning acrylate polymers possess low sensitivity, low etch resistance, potential outgassing, and poor base solubility but have shown excellent performance with regard to resolution and LER. This paper will present the results of studies of resist parameter space that is bounded by these technologies which allow for hybridization. Details will be presented on:

1. Low chemical amplification combined with scissioning mechanisms through co-polymerization of acrylates and acrylate derivatives
2. Ionizing radiation resists for DUV (193nm) application, including polymeric ketones, depolymerization systems, crosslinking systems and copolymeric systems containing functional goups that are sensitive to PAGs
3. Molecular glass resists of ring and branched structure to explore the influence of small molecular size on LER, PAG miscibility and overall resolution
4. Stars or branched architecture to explore the idea that control of charge distribution and chain architecture enhances the development process and reduces LER effects
5. Application of ongoing EUV resist development strategies for 193m application, including methods for stringent control of acid diffusion