Approaches to EUV Photoresists:
Polyacetals and Polypeptoids Offer New Options

Jingyuan Deng, Florian Kaefer, Christopher K. Ober
Materials Science and Engineering,
Cornell University, Ithaca NY 14853-1501

Zoey Meng, Rachel Segalman
Chemical Engineering and Materials
UC Santa Barbara, Santa Barbara, CA, 93106-5080

Low stochastics, high sensitivity photoresists remain a goal for EUV lithography. Here we present studies of two polymer systems with the goal of making improvements to these resist characteristics using two different chemical approaches. In one system we work on scissionable poly(phthalaldehyde) modified to enable incorporation of photoactive units on each repeat unit of the polymer chain. In a second system we explore peptoid polymers that possess identical molecular size and composition with much higher molecular uniformity than possible by conventional synthetic techniques.

In our study of poly(phthalaldehyde) we have modified the basic building block by adding a substituent in order to incorporate units that make the basic polymer both more susceptible to EUV exposure and more likely to depolymerize after exposure while remaining stable in the absence of radiation. Each chain is made of identical building blocks and by using anionic polymerization has a very narrow molecular weight. Our premise is that while the polymer itself may not be of uniform molecular size (although with narrow dispersity as it is made by living polymerization methods), this is less important because the patterning mechanism involves depolymerization (conversion of polymer to monomer) and removal of the polymer in the exposed area.

In a second resist material, we explore the construction of polymers derived from peptoid units. This polymer family, prepared using a robot synthesizer system originally developed for protein synthesis, is produced on a substrate and can be made in gram quantities. Attachment to a substrate enables exquisite control of the polymer formation chemistry. The number of units in each chain is identical and the average composition is identical, thus minimizing issues of compositional statistics. The efficiency of peptoid preparation (compared to peptides) means that resist molecules ranging from 10 to 20 or more repeat units are easily produced. Recent simulations by researchers at Lawrence Berkeley have shown very interesting scission behavior of amide bonds under EUV radiation. Both the potential for molecular weight control and these simulations prompt our studies.

We report the results of exposure of these materials to DUV/EUV exposures and the chemical changes that occur.