The Photopolymer Science and Technology Award

The Photopolymer Science and Technology Award No.111100, the Outstanding Achievement Award 2011, was presented to Ralph R. Dammel (AZ Electronic Materials Corporation) for his outstanding achievements in photopolymer science and technology, “Development of new advanced resist materials for microelectronics”.

Ralph R. Dammel is the Chief Technology Officer (CTO) for AZ Electronic Materials USA Corporation. He received M.S (1981) degree in chemistry from the J. Gutenberg University, Mainz/FRG, and Ph.D. (1985) degree in chemistry from the J.W. Goethe University, Frankfurt/FRG. He joined Central Research Laboratories, Hoechst AG, Frankfurt/FRG in 1986, and began his career in photolithography. He was promoted to a project leader on diazonomaphthoquinone photosensitizers and advanced resin systems for i-line photolithography in 1991. After that, he had engaged in development of 193 and 157 nm resists as a director of technology, was promoted to a vice president of Global R&D in 2006, and to Chief Technology Officer (CTO) in 2008. He is an SPIE Fellow.

Dr. Dammel has engaged in development of many photoresists including i-line, DUV, 157nm, 193nm, 193nm immersion, e-beam, and X-ray resists, and contributed to the progress of photopolymer science and technology as described below.

1. He carried out fundamental works on photoactive compound chemistry and synthesis of novolaks, and wrote a book, “Diazonaphthoquinone-based resists”, which was published in 1993 by SPIE press, and which is still considered the definitive monograph on the topic today. [1]

2. His group developed negative-tone chemically amplified resists (e.g., AZ PN114) which showed very high resolution. Initially, these resists were used for x-ray mask copying, but they soon found a larger use in e-beam lithography. [2]

3. His group developed a number of analytical and simulation techniques to help us better understand the underlying physical phenomena. Together with the teams at the Berlin Fraunhofer Institute, they worked on some of the first simulation models for chemically amplified resists, and also introduced the concepts of percolation theory and fractal dimension for characterization of surface roughness into lithography. [3]

4. He worked on the application of percolation theory to photoresist development rates, which led to the explanation of the strongly non-linear effects of DNQ addition to novolaks known as Meyerhofer’s plot. [4]

5. His group found that 3-methyl-4-hydroxystyrene (MPHS) was one of the most promising PHS derivatives. MPHS has the advantage of a lower $T_g$, which means that resists based on it can easily be annealed during softbake, which leads to improved contamination resistance. [5]

6. He was interested in the development of novel PAGs with optimized acid strength and diffusion properties, as well as the study of photosensitive base additives that are neutralized by a photoreaction in the exposed area, but continue to act as bases and suppress acid diffusion in the unexposed resist. These efforts led to significant reduction in the line edge roughness of our 193 nm photoresists. [6]

7. His group developed 157 nm photoresists based on fluorinated polymer platforms, and introduced the world’s first commercial 157 nm resist in 2003. [7]

8. His group developed resists with fluorinated co-monomers that had higher receding contact angles and could be combined with low-leaching PAGs to give resists that did not require a top coat. [8]

He has published more than 200 articles in the area of microlithography and polymer chemistry and is an inventor on over 80 patent families. Furthermore, his important research results have been presented at the annual Conference of Photopolymer Science and Technology every year and his many papers have been published in Journal of Photopolymer Science and Technology.
As described above, Dr. Dammel has encouraged outstanding scientific researches for design and synthesis of new advanced resist materials in microlithography.

References


Mitsuru Ueda
Tokyo Institute of Technology