MAR12-2011-020236

Abstract for an Invited Paper
for the MAR12 Meeting of
the American Physical Society

Polymer and Material Design for Lithography From 50 nm Node to the sub-16 nm Node[1]

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Microlithography is one of the technologies which enabled the Information Age. Developing at the intersection of optical physics, polymer science and photochemistry, the need for ever smaller high fidelity patterns to build integrated circuits is currently pushing the technology evolution from 193 nm immersion lithography to extreme ultraviolet lithography (13.5 nm) to alternate patterning technologies such as directed self assembly (DSA) of block copolymers. Essential to the success of this progression is a rapid application of new concepts and materials in polymer science. We will discuss the requirements for 193 immersion lithography and how advanced acrylic random polymers are being designed with chemical amplification functionality to meet these needs. The special requirements of a water immersion lithography led to the invention and rapid commercial application of surface assembled embedded barrier layer polymers. Design of polymers for EUV lithography is having to respond to much different challenges, prominent being the dearth of photons in the exposure step, and the other being how to maximize the efficiency of photoacid production. In parallel, alternative lithographic approaches are being developed using directed self assembly of block copolymers which realize pattern frequency multiplication. We will update with our progress in the applications of polymers designed for DSA.

[1]In collaboration with Phillip D. Hustad, George Barclay, Jim Thackeray, Deyan Wang, Shih Wei Chuang, Vivian P. Chuang, Valeriy Ginzburg, Jeffrey D. Weinhold, and Rahul Sharma, The Dow Chemical Company.