Metal-Organic Hybrid Photoresists

CNF Project Number: 386-90
Principal Investigator(s): Christopher Kemper Ober
User(s): Kazunori Sakai, Seok-Hyon Jung, Wenyang Pan

Affiliation(s): Materials Science and Engineering, Cornell University
Primary Source(s) of Research Funding: JSR Corporation
Contact: christoper.ober@cornell.edu, ks2288@cornell.edu, sj736@cornell.edu, wp222@cornell.edu
Primary CNF Tools Used: Zeiss Supra SEM, ASML 300C DUV stepper, ABM contact aligner

Abstract:

While extreme ultraviolet (EUV) lithography is being investigated for patterning under 20 nm half pitch pattern size, further improvement is needed for achieving high volume manufacturing. EUV lithography uses a wavelength of 13.5 nm and this brings about the biggest problem of EUV lithography that a typical EUV power source is incapable of generating enough photons compared to other light sources. In this circumstance, materials enabling use of fewer EUV photons have been investigated. In this report, microscale patterning results of metal-organic cluster resists with high EUV absorption composition and EUV exposure results of zinc organic cluster resist on different underlayer are described.

Summary of Research:

While continuous effort has been dedicated to the extreme ultraviolet (EUV) lithography to follow Moore's law, further improvement is needed for achieving high volume manufacture.

One of the reasons why manufacturing by EUV lithography has taken a longer time to develop than other lithography techniques is typical EUV sources provide fewer numbers of photons than other light sources. In terms of materials, photoresists including higher EUV absorption and better underlayer materials absorbing EUV transmitted through the photoresist and assisting additional generation of acid have been investigated. Inorganic elements possess higher EUV absorption than organic elements and EUV photoresist, including metal oxide nanoparticles or metal complexes have been attracting interest.

We developed hafnium and zirconium oxide nanoparticle resist and have recently focused on developing zinc-organic cluster resist with controlled molecular weight and size distribution [1].

In this report, the lithography performance of other metal-organic cluster resists and the effect of underlayer for EUV lithography performance are discussed. The micro-scale patterning results are shown in Figure 1.

Transition metals such as Group 4 metals, cobalt and nickel and non-transition metals such as indium and tin are available. Especially, cobalt and nickel are expected to absorb more EUV light, and further study will be investigated.

The EUV exposure results of zinc-organic cluster resist on the different underlayer are summarized in Figure 2. The introduction of underlayer has improved the sensitivity with the almost same LWR value. The mechanism based on this phenomenon will be elucidated.

References:

[1] Xu, H., Sakai, K., Kasahara, K., Yang, K., Herbol, H. C., Odent, J., Clancy, P., Giannelis, E. P., Ober, C. K., Metal-Organic Framework-inspired metal-containing building units for high resolution patterning, Chem. Mater. 2018, 30, 4124-4133.

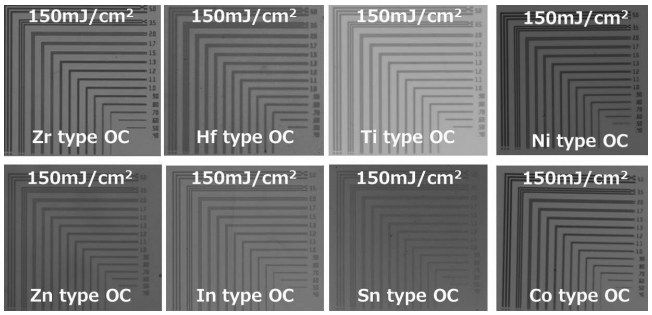

Figure 1: Optical microscope images of micro-scale patterning using the ABM contact aligner.

Resist	Sample-A	Sample-A	Sample-A	Sample-A
Substrate	Bare-Si	UL-A	UL-B	UL-C
Image @16nmLS	67mJ/cm2 LWR 5.0nm	58mJ/cm2 LWR 5.2nm	51mJ/cm2 LWR 5.6nm	54mJ/cm2 LWR 5.2nm

Figure 2: SEMs of EUV exposure results with zinc organic cluster resists.