The Photopolymer Science and Technology Award


Akira Kawai is Associate Professor at Faculty of Engineering, Nagaoka University of Technology. He received his B.S., M.S. and Ph.D.(1994) degrees from Nagaoka University of Technology. From 1983 to 1994, he worked at LSI Laboratory, Mitsubishi Electric Corporation. Past research has included bi-layer and tri-layer resists, CEL, ARC, DUV hardening processes and adhesion improvement of resist micro patterns. He also engaged the development of DRAM, SRAM, EPROM and ASIC devices. His current research interests include the development of analysis method of nanoscale lithography with atomic force microscope (AFM), such as adhesion and mechanical properties, condensation control of polymer aggregates, nanoscale wetting, and adhesion analysis of nanoscale bubbles for immersion lithography. He has about 100 publications and holds about 100 Published patent applications (Japan patents) in the area of microlithography and surface science. He received the Progressive Award (1999) and the Best Paper Award (2003) from the Adhesion Society of Japan

Takayoshi Niiyama is working for his Ph.D degree at graduate school of Engineering in Nagaoka University of Technology. He received his B.S. and M.S. degrees in Electrical Engineering from Nagaoka University of Technology in 2003 and 2005, respectively. His research M.S. was the control of interaction force acting between solids in nanoscale for advanced lithography. His current research interests are the development of analysis method of repulsive interaction force in nanoscale gap with atomic force microscope (AFM) and the development of advanced devices in nano and microscale such as micro wetting systems.
Masahito Hirano received his B.S. degree in 2002 and his M.S. degree in 2004 in Electrical Engineering from Nagaoka University of Technology. In his master’s thesis, the meniscus interaction between pure water and resist pattern in nano-scale is characterized by using atomic force microscope. Now he is working at Shin-Etsu Engineering Co., Ltd.

Makoto Sakata received his B.S. degree in Electronic and Electrical Engineering, Gunma University in 2002. During the study for B.S. he was involved in carbon nanotube production by arc discharge. In 2004, he received his M.S. degree from Nagaoka University of Technology for research of photo lithography, especially rinsing process of photoresist. Then he joined Hoshino Kogyo Co., Ltd. in 2004. His current interests include product development of various weavings which are used for seatbelt, airbag, etc.

Atsushi Ishikawa received his B.S. and M.S. degrees in Electrical Engineering from Nagaoka University of Technology in 2003 and 2005, respectively. And then he joined Mitsubishi Materials Corporation. His study for M.S. was the elucidation of intrusion mechanism of liquid into 180nm photoresist pattern. His research included basic studies of nano-bubbles for the development of 193nm immersion lithography.

With increase in density of semiconductor, the minimum feature size of patterns has been scaled down to below 100nm [1]. The development of lithography and resist technology is accelerated to meet the requirements. One of current topics of lithography is immersion lithography [2]. Using immersion lithography, 65nm to 45nm node patterns can be fabricated with ArF (193nm) exposure [3-6]. Other topic is extreme ultraviolet (EUV) lithography, which adjusts for 32nm node owing to very short exposure wavelength (13nm) [7-9]. Along with these fabrication techniques,
fundamental technology is strongly needed to understand essence of these techniques. It will lead to the further development for lithography technologies.

Authors have developed various analysis methods of lithography with atomic force microscope (AFM) and applied these to understanding of lithography essence, such as adhesion and mechanical properties, condensation control of polymer aggregates and nanoscale wetting. Their group has been a pioneering group for this novel technology.

Cohesion property of resist pattern surface was analyzed. It was found that a certain hardened thin layer is formed on the surface after resist pattern development. These results are enhanced by the various hardening processes such as electron beam (EB) irradiation and thermal curing [10].

In various humidity conditions, the interaction behavior between a resist film surface and an AFM tip was characterized. The micro defect such as resist fragment is attracted to the resist pattern in vapor condition. Absorption of water to the resist pattern influences the micro defect [11].

The drying process of the rinse water strongly affects pattern collapse phenomena during resist development. In order to analyze the water meniscus behavior, a PET film is used as a parallel pattern. With drying of water, an air tunnel is formed and water divides to top area and bottom area. Stress condensed in an air tunnel leads to a pattern collapse [12].

The drying speed of rinse water depending on pattern arrangement was analyzed. The rinse water is more likely to remain at dot array patterns as compared with line-and-space patterns. This is due to pinning effect which causes liquid trap around resist patterns [13].

These original research works are valuable for fine pattern fabrication techniques of lithography in terms of basic findings of state of resist surface or rinse process. In other words, authors’ significant research results very contribute to semiconductor industry. Their important researches have been presented at the annual Conference of Photopolymer Science and Technology and 27 issues of the papers have been published in Journal of Photopolymer Science and Technology. These contributions give the fundamental aspects of lithography technologies and open an advanced technology field of nanoscale fabrication [10-36].

References

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