The Photopolymer Science and Technology Award

The Photopolymer Science and Technology Award No. 112200, the Best Paper Award 2011, was presented to Yoshihiko Hirai (Osaka Prefecture University, JST-CREST) for their outstanding contribution published in Journal of Photopolymer Science and Technology, 23, (2010) 25-32, entitled “UV-Nanoimprint Lithography (NIL) Process Simulation”.

Yoshihiko Hirai received BS and MS degrees in electronics engineering in 1979 and 1981, respectively. He joined Matsushita Electric Industrial Co. Ltd. in 1981. He worked on advanced semiconductor lithography process technology at the central research laboratory and the semiconductor research laboratory. He received Doctor Degree from Osaka Prefecture University in 1995 for his researches on photolithography simulation works.

In 1996, he joined Osaka Prefecture University at mechanical systems engineering as an associate professor. He started research on nanoimprint lithography in 1998.

In 2004, he was promoted as a professor at physics and electronics engineering. His current interest lies on nanoimprint technology and it’s application.

He was a visiting scholar of Center for Integrated Systems at Stanford University in 1999.

UV nanoimprint [1-4] is a promising new lithography technology with extremely high resolution. UV nanoimprint has received a lot of attention from the viewpoint of mass production in recent years because it does not require very high imprint pressure or application of heat. However, resist patterns fabricated by UV nanoimprint technology had various defects such as defective filling of the resist, bubble defects [5], and damage during demolding, etc [6].

Prof. Hirai's group has clarified one by one the various phenomena of the UV nanoimprint process by the simulation technique [7-11]. This award-winning paper is a review of these results. First of all, they examined the mechanism of the resist filling of the template in both the case of the droplet process and the spin coating process [7]. The behavior of the filling of the resist was shown to depend on its viscosity, the surface energy of the template and the substrate, and the infusion rate of the resist. The mechanism of bubble defect formation can be understood by clarifying this phenomenon, and the method for eliminating the bubble defect is suggested. In UV nanoimprint, there is a process in which the resist is cured by UV irradiation. They researched how optical intensity changes by the pattern shape of the template and the refractive index of the resist [8]. It was shown that irregularity in hardening of the resist occurs under certain conditions of the refractive index value of the resist and the pattern size of the template. Moreover, the hardening behavior of the resist under UV irradiation is examined [9,10]. They clarified that the resist shrank greatly when the properties of the resist changed from viscous to viscoelastic by UV irradiation. There is a process of demolding as the last step of UV nanoimprint. They examined the deformation of pattern shape and stress caused by the cure shrinkage of the resist. By this examination, it was shown that there was a tendency for the pattern to shrink more in either the X-Y axis direction or the Z axis direction, in which direction depending on the pattern shape. It was also shown that the stress caused by cure...
shrinkage is different between the center part and the outer part of the template.

As described above, Prof. Hirai's group has clarified the phenomenon in each individual process of UV Nanoimprint by the simulation technique. Their important research results have been presented at the Conference of Photopolymer Science and Technology 2010 and the paper has been published in Journal of Photopolymer Science and Technology [11]. These results are useful for not only the clarification of various phenomena of UV nanoimprint but also for understanding the behavior of UV curable resin in the nanometer or micrometer dimension. These results deepen our understanding of the process of the UV nanoimprint and contribute to establish UV nanoimprint as an important microfabrication technology in industry.

References

Yasuhide Kawaguchi
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