Release property of fluorinated silica surfaces for UV-curable resins evaluated by fluorescence microscopy and mechanical measurement

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UV nanoimprint is a promising nanofabrication technology at high throughput. An antisticking reagent is often utilized for an imprint mold surface to prolong a mold life. An ultrathin antisticking layer exhibiting high durability is necessary to realize mass-productive replication by UV nanoimprint and to ensure critical dimension control of imprinted patterns on deca-nano scale. However, there is not a clear guideline to choose a UV-curable resin suitable for an antisticking layer.

We have recently developed a mechanical measurement system [1] and a fluorescent UV-curable resist [2] to look for an ultrathin antisticking molecular layer suitable for UV-curable resins. The mechanical measurement system enabled us to evaluate an adhesive force generating when a modified silica lens surface is detached from a UV-cured resin [1]. Among fluorinated alkyltrimethoxysilanes, a self-assembled monolayer formed from tridecafluoro-1,1,2,2-tetrahydrooctyltrimethoxysilane (FAS13) by chemical vapor surface modification showed antisticking property and exhibited stable and relatively small adhesive forces on repeated detachments from a UV-cured resin. Octyltrimethoxysilane showed high adhesive forces than FAS13 and often resulted in resin stuck to a modified silica surface. Low surface coverage of FAS13 caused increasing adhesive forces and enlarged their standard derivation. Several molecules played a role of reducing adhesive forces for a UV-curable resin causing radical photopolymerization.

We demonstrated that a fluorescent UV-curable resist was useful for profiling residual layer thickness [2] and for inspecting defects [3] in an imprinted pattern on a wafer. In addition, use of condensable gas pentafluoropropane in step-and-repeat UV nanoimprinting suppressed adsorption of resin components to a fluorinated silica mold surface [4]. It was found that such resin adsorption depended on the kind of antisticking reagents [4].

In my talk, I will summarize release property of fluorinated silica surfaces for UV-curable resins evaluated by fluorescence microscopy and mechanical measurement.

References

[1] JP2009-206133 (applied to US, CN, and KR)
[2] Jpn. J. Appl. Phys., **49**, 06GL07 (2010)
[3] J. Vac. Sci. Technol. B, **28**, C6M50 (2010)
[4] Submitted to Jpn. J. Appl. Phys.

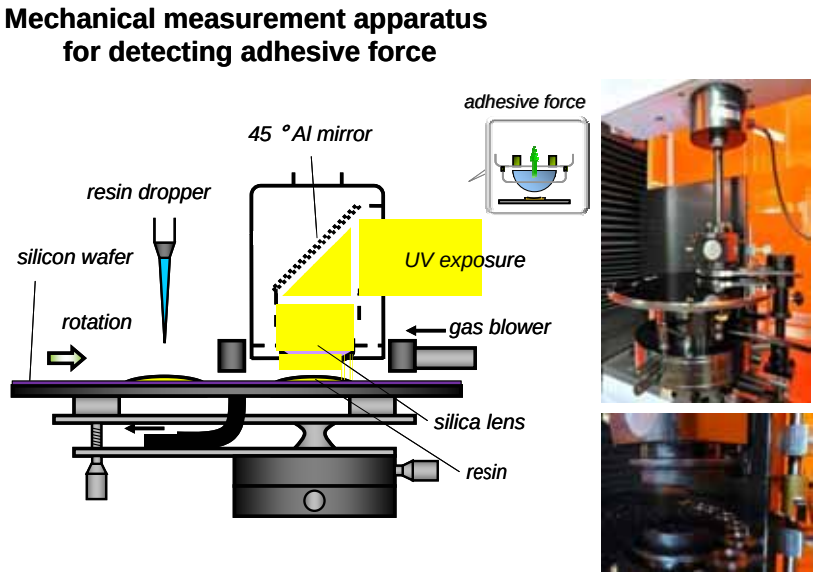

Fig. 1. Illustration and photographs of a mechanical measurement apparatus for detecting adhesive forces on repeated detachment of UV-cured resin.

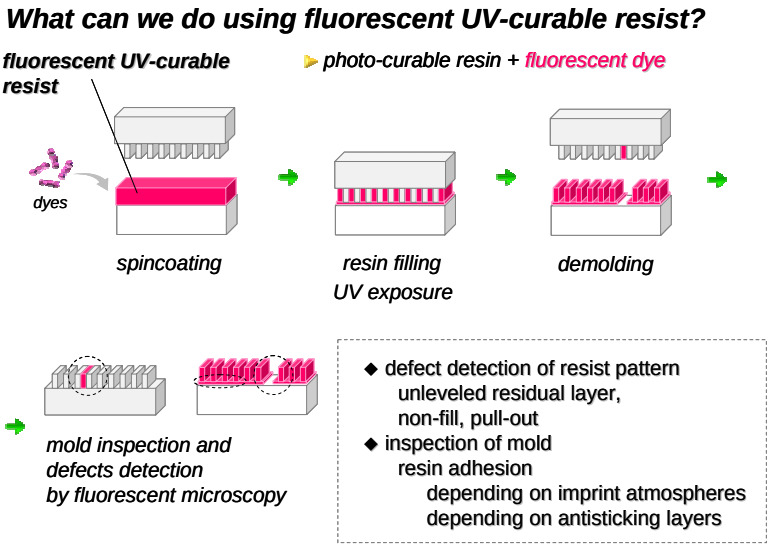

Fig. 2. Schematic illustration of UV nanoimprinting using a fluorescent UV-curable resist and its advantage.