Adhesion force evaluation of UV-curable nanoimprint resins by scanning probe microscopy with UV irradiation system

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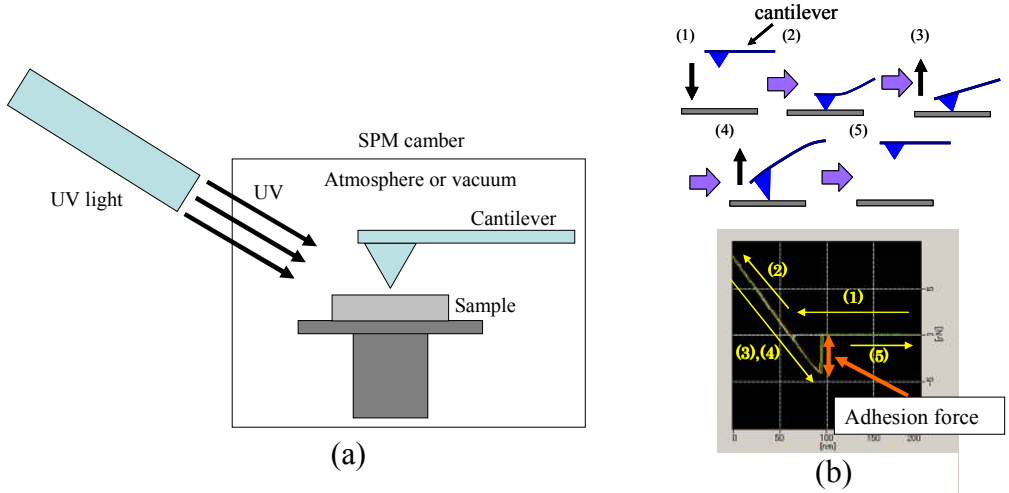
UV-curable resins are one of the most important factors in UV nanoimprinting and they are mainly categorized in two reaction types, radical and cation curing systems. Adhesion force evaluation of the UV curable resins is important because this force affect the demolding force in UV nanoimprinting. In this study, we evaluated the locoregional adhesion force of radical- and cation-UV curable resins by scanning probe microscopy (SPM) with UV irradiation system.

We used E-sweep/NanoNavi Station (SII NanoTechnology Inc.) as the SPM system because this system is used to control the experimentation environment such as vacuum and UV irradiation. PAK-01-60(Toyo Gosei Co.) was used as the radical UV curable resin. PAK-01-60 was spin-coated on the Si substrate and the substrate was prebaked at 80 °C for 2min. Figure 1(a) shows the schematic of the SPM system with UV irradiation system. UV irradiation system is placed at outside of the SPM chamber and UV is exposed to the sample through the quartz window of the SPM chamber. We can repeat the SPM measurement and UV irradiation. Figure 1(b) shows the principle of the force curve measurement by SPM and an example of the force curve. [1)] The force curve is obtained from the deflection of the cantilever. In this study, we used a Si cantilever. We first measured the force curve of PAK-01-60 before and after UV (365 nm, 5.7 mW/cm^2) irradiation for 190 sec at atmosphere, as shown in Fig. 2. The force curve of the resin after UV irradiation was almost the same at that before UV irradiation because it was not perfectly cured by oxygen inhibition. We next irradiated UV to the PAK-01-60 at a vacuum pressure of 15 Pa and measured the force curve at the atmosphere. Figures 3(a), 3(b), 3(c), and 3(d) show the force curves of the PAK-01-60 before and after UV irradiation for 8, 24, and 48 sec, respectively. As the result, we obtained the clear force curve in this case. This result indicates that the radical curing system is strongly-affected by oxygen. We demonstrated that SPM with UV irradiation system is useful to evaluate the adhesion force of the UV-curable resin through the curing process.

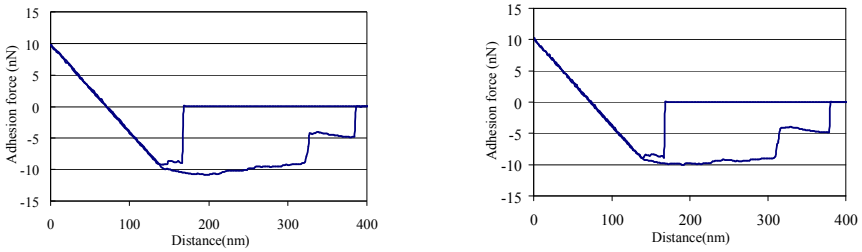
In the presentation, we will present the comparison of adhesion force between radical and cation UV curable resins by using this measurement.

1) H. A. Mizes, et al.: Appl. Phys, Lett. **59** (1991) 2901



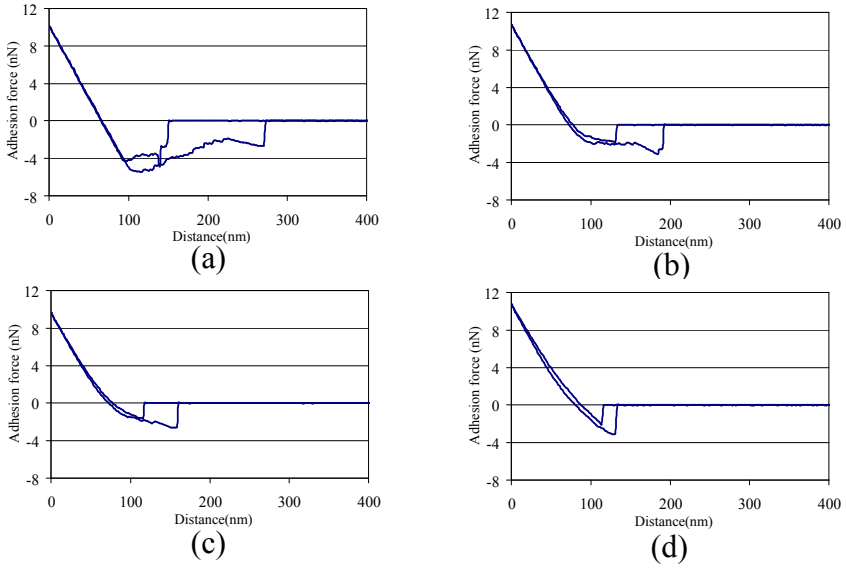
(a) (b)

Figure 1. (a) Schematic of SPM system with UV irradiation system. (b) Principle of force curve measurement by SPM and example of force curve.



(a) (b)

Figure 2. Force curves of PAK-01-60 (a) before and (b) after UV irradiation at atmosphere.



(a) (b) (c) (d)

Figure 3. Force curves of PAK-01-60 (a) before and after UV irradiation for (b) 8, (c) 24, and (d) 48 at vacuum pressure of 15 Pa.