Affordable Homemade Lab-scale UV Imprinting Device

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Micro/nano-imprinting is a widely recognized technique used to replicate structural patterns. This research is popular among research institutions, companies, and universities. However, the cost of purchasing UV imprinting equipment is high; especially for a startup laboratory, it is nearly impossible to buy the equipment to perform relevant experiments.

In this study, a cost-effective and easy-to-build UV imprinting device is introduced, suitable for laboratories in the early stages of exploring UV imprinting. The device mainly comprises a digital force gauge, a height-moving stage (not shown in Figure 1), an imprint block, UV light, and a floating joint, as shown in Figure 1. The most crucial component among these is the floating joint, which can rotate freely in three directions. With the help of this floating joint, the compliance of the imprinted surface is improved during the imprinting process, resulting in a significantly uniform imprinted outcome. The digital force gauge monitors the imprinting pressure; the imprinting process is stopped manually when the imprinting pressure reaches the setting value. In terms of cost, the digital force gauge and the floating joint can be bought for under USD 150 and USD 4, respectively, showing a tremendous cost advantage.

The performance of the floating joint was verified by imprinting UV resin with a 28 x 28 mm^2 PDMS mold with 5 N pressure, 0 s holding time, and 5 μm/s imprinting speed. Figure 2 shows the SEM cross-section images of residual layer thickness. Without the floating joint, there was a significant difference in thickness, which decreased considerably with the floating joint. Figure 3 shows that the thickest layer was 117.3 μm, and the thinnest was 34.2 μm when imprinting without the floating joint. On the other hand, the thickest layer was 23.3 μm, and the thinnest was 16.0 μm with the floating joint installed. The thickness range without the floating joint was as high as 83.1 μm, but it decreased to 7.3 μm after installation. Moreover, a grating of the triangle microstructures with 50 μm width and 25 μm height was transferred completely.

In conclusion, a UV imprinting device for laboratory use can be created at a reasonable cost by using a digital force gauge and a height-adjustable stage. Adding a floating joint to the device can also enhance the uniformity of the imprinting process. Additionally, if this imprinting device is mounted on a 3-axis gantry, it can fabricate large-area samples employing stitching imprinting.

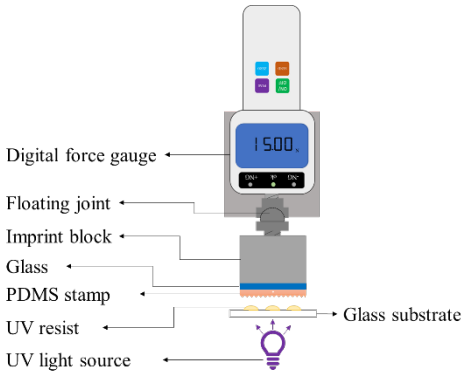

Figure 1: Setup of Lab-scale UV Imprinting Device: The main components of a lab-scale UV imprinting device are the digital force gauge, imprint block, UV light, and the most crucial element, the floating joint.

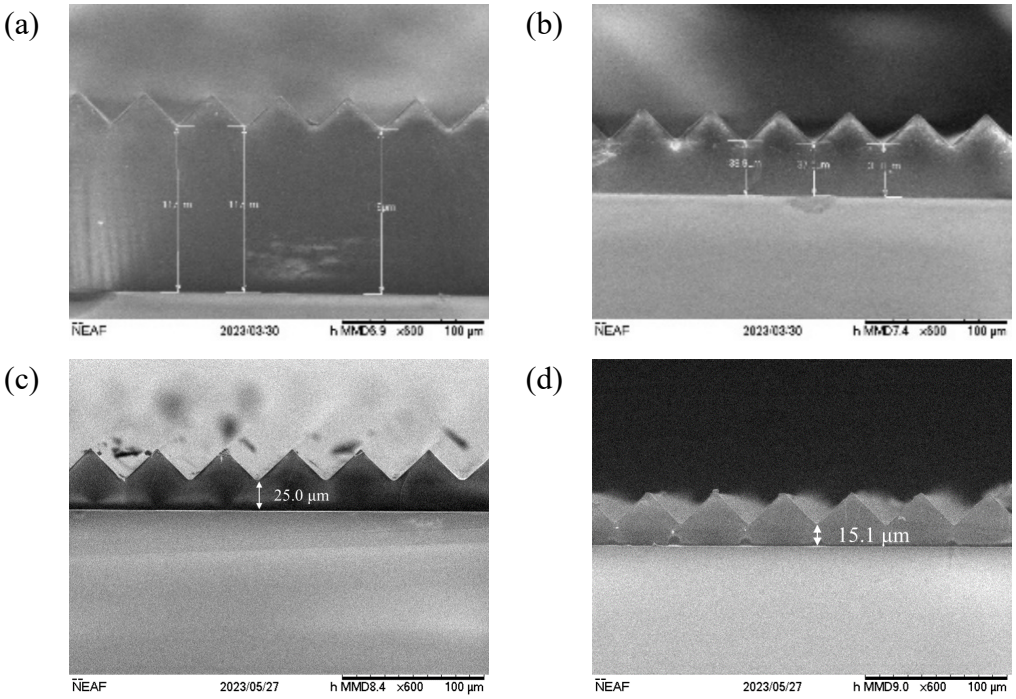

Figure 2: SEM Images of Imprinted Results: (a) and (b) show the thickest and thinnest residual layer of imprinting w/o the floating joint. (c) and (d) show the thickest and thinnest residual layer of imprinting with the floating joint.

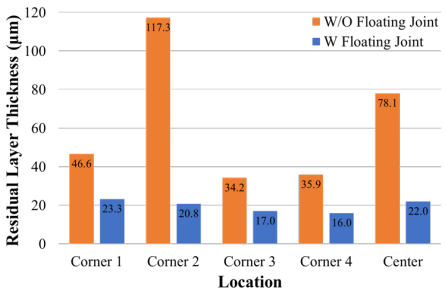

Figure 3: Comparison of Residual Layer Thickness with/without Floating Joint.