Complete reversal imprinting for fabricating microlens array with high height transcription

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Abstract

Microlens array has been regarded as a key component in many electro-optical devices. For fabricating microlens array, methods such as thermal reflow, UV proximity printing, hot embossing, and hot intrusion have been reported. During these processes, the height transcription of microlens array is affected by the processing parameters (e.q., temperature, pressure, time), indicating a precise adjusting of processing parameters is needed in order to achieve the high height transcription of microlens array. Therefore, a fabrication process for microlens array with full height transcription is needed. Recently, reversal imprinting technique has been reported. During the reversal imprinting process, the UV-curable resin is coated onto the stamper with micro/nano-pattern cavity instead of onto the substrate, and the stamper (upside) is brought into contact with substrate (downside) and presses them. In this work, reversal imprinting is employed by coating the UV resin onto the stamper. Furthermore, we modified the imprinting mechanism by pressing the substrate (upside) and the stamper (downside) coated with UV resin. With such arrangement, the low-viscosity UV-resin can remain in place without flowing down as shown in Fig. 1. With this modification of reversal imprinting, the microlens array with full transcription could be easily achieved without the control of processing parameters.

In this study, the effects of the pressing pressure, UV irradiation energy, and pressing duration on the height transcription of microlens array have been investigated. Fig. 2 and Fig. 3 show the effect of pressing duration time and pressing pressure on the height transcription of microlens array, respectively. Results demonstrate that the height transcription of microlens array does not increas with the pressing duration time and pressing pressure. In other words, the pressing duration time and pressing pressure do not affect the height transcription of microlens array much. The height variation is caused by the measuring error of White-Light Interferometry. Figure 4 shows the height transcription of microlens array using different UV irradiation energy. It is found that the height transcription of microlens array is not affected by the exposure energy either.

This work reports a reversal imprinting mechanism with a modified relative position of substrate and stemper. With the UV resin coated stamper pressed in the bottom, there is no fear of flowing down of the low-viscosity UV resin. Experiments further show that the full height transcription of microlens array can be easily achieved, regardless of the processing parameters.

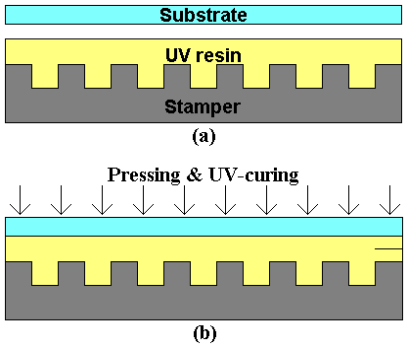

Fig. 1. Schematic of the complete reversal imprinting process for the fabrication of microlens array.

process.

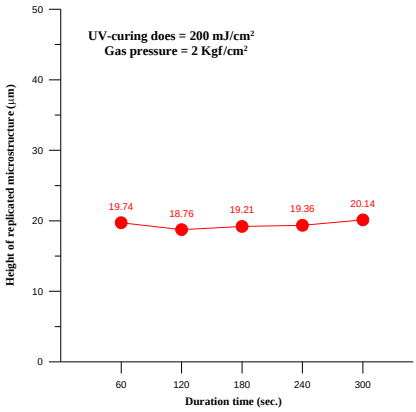

Fig. 2. Replicated height of microlens array under various duration time in the complete reversal imprinting process.

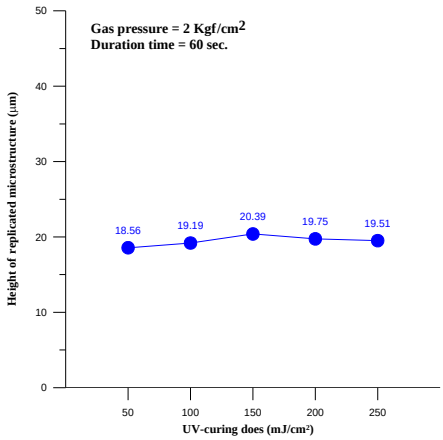

Fig. 3. Replicated height of microlens array under various gas pressure in the complete reversal imprinting process.

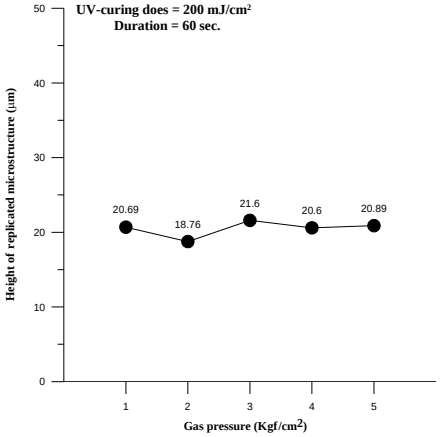

Fig. 4. Replicated height of microlens array under various UV-curing does in the complete reversal imprinting