Fabrication of Fine Plastic Microchannel by Using Hot embossing

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INTRODUCTION

In micro fluidic applications for chemical analysis and chemical reaction, plastic materials are getting substantial attracts. PMMA has been widely used for micro fluidic device application due to easy fabrication and low cost [1]. Some PMMA devices such as electrophoresis chips have been reported [2]. These devices reported so far were consisted of two parts, PMMA substrate having the microchannel and a flat substrate as the cover plate. Flat bottom and slanted sidewalls for easy removal was usually obtained. However some fluidic applications require parallel vertical sidewalls. In this paper, we studied hot embossing method realizing PMMA microchannel that has vertical sidewall.

EXPERIMENT

For the fabrication of the mold master, rectangular silicon structures of 30μm in depth were formed by Deep-RIE. The vertical sidewall of silicon mold was realized with this method. Figure 1 shows the silicon mold microphotographs of SEM and Optical microscope.

50, 100, 150μm width microchannels were prepared for the mold master. A PMMA of 20mm x 20mm x 1mm were used substrate. Fabrication procedure of hot embossing is illustrated on figure 2. Hot embossing equipment (EVG520HE, EVG Co.), high pressure and precise temperature control was used for the experiment. The key issues for realizing fine plastic structures are the temperature, applied pressure and time. The embossing temperature is most effective to obtain the fine vertical PMMA structure. Typical emboss temperature for microchannel fabrication was 120 degree C and the pressing force was 700 N. The other issue is removal from the silicon mold. To keep fine vertical structures, the removal temperature is controlled at 82 degree C, just under Tg of PMMA.

RESULTS

Figure 3 is the photomicrograph of the fabricated PMMA microchannel. Even acute angled vertical structures were obtained by this method. To evaluate the cross sectional microchannel structure, PDMS replica was cast. Figure 4 shows the cross sectional view of PDMS replica. From these results, fine microchannel having vertical sidewalls are realized by optimizing the embossing condition with silicon mold. microchannel junction at acute and right angle were transferred from the silicon mold.

This hot emboss technologies are also applied to other polymer material such as fluororesin. Figure 5 shows hot embossing result about microchannel on fluororesin substrate.

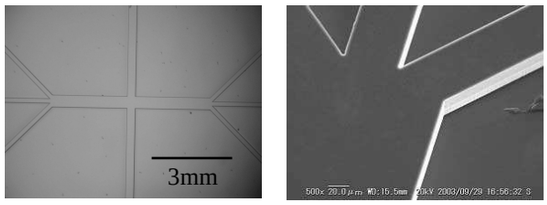
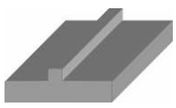


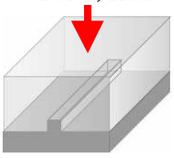
Figure 1. Microphotographs of silicon mold.



Silicon mold

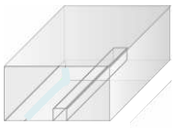
Photolithography and dry etching

Force, Heat



Hot emboss

Force, Temperature, Time



Microchannel

Remove the microchannel substrate from mold

Figure 2. Fabrication procedure of hot embossing

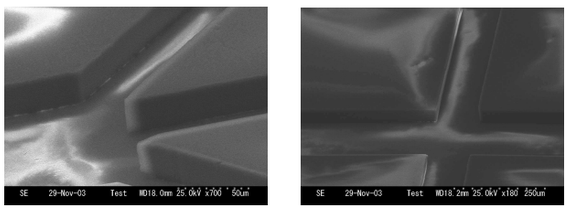


Figure 3. Photograph of the embossed PMMA substrate.

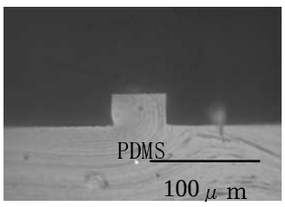


Figure 4. PDMS replica microphotograph.

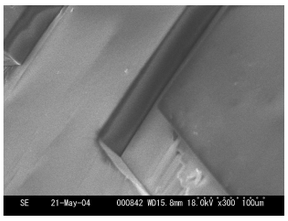


Figure 5. Photograph of the embossed fluororesin substrate. (SEM image)

REFERENCES

[1] H. Becker *et al.* Reviews in Molecular Biotechnology, **82**, p. 89 (2001).
[2] L. Martynova *et al.* Anal.Chem., **69**, p. 4783 (1997).