Barriers Ribs using Molds Prepared by Inclined UV Lithography

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Abstract

Closed-cell type barrier ribs of PDP were formed by capillary molding process using molds prepared by inclined UV lithography process. Various types of molds with different inclined angles were prepared by patterning SU-8 thick photoresist film and casting with PDMS. The ribs with various type cells were successfully formed by the process. The effects of inclined angle on the distortion of barrier ribs during sintering were investigated. The results indicated that the barrier ribs with a draft angle and dimensional change does not affect the distortion of the barrier ribs during sintering, suggesting that the closed-cell must be isotropic in sintering shrinkage.

1. Introduction

For the improvements in luminance efficiency, contrast ratio and image quality of PDP, closed-cell type barrier ribs such as SDR, DelTA, and honeycomb are being proposed recently [1-5]. These closed-cell type ribs are being produced by several routes such as sandblasting, chemical etching, photolithography, and capillary molding processes [6].

Among the processes, the capillary molding process produced barrier ribs of finely controlled morphology [7]. In the molding process, a thermally curable paste is coated on a substrate and a mold with barrier rib channels engraved is place on the top of paste. Upon contact with the mold, the paste fills the channel with the action of capillary pressure. After the filling of the paste, sample is thermally cured and the mold is removed prior to sintering. Although this process is capable of producing barrier ribs of high aspect ratio larger than 4, side-walls of the ribs produced are perpendicular to substrate as shown in Fig. 1. This morphology has several demerits such as stress concentration at the bottom corner and difficulty in forming phosphor layer. These demerits should become more problematic as the width of the ribs becomes thinner. Barrier ribs with a controlled draft angel should reduce the stress concentration at the corner and improve the workability of phosphor layer coating.

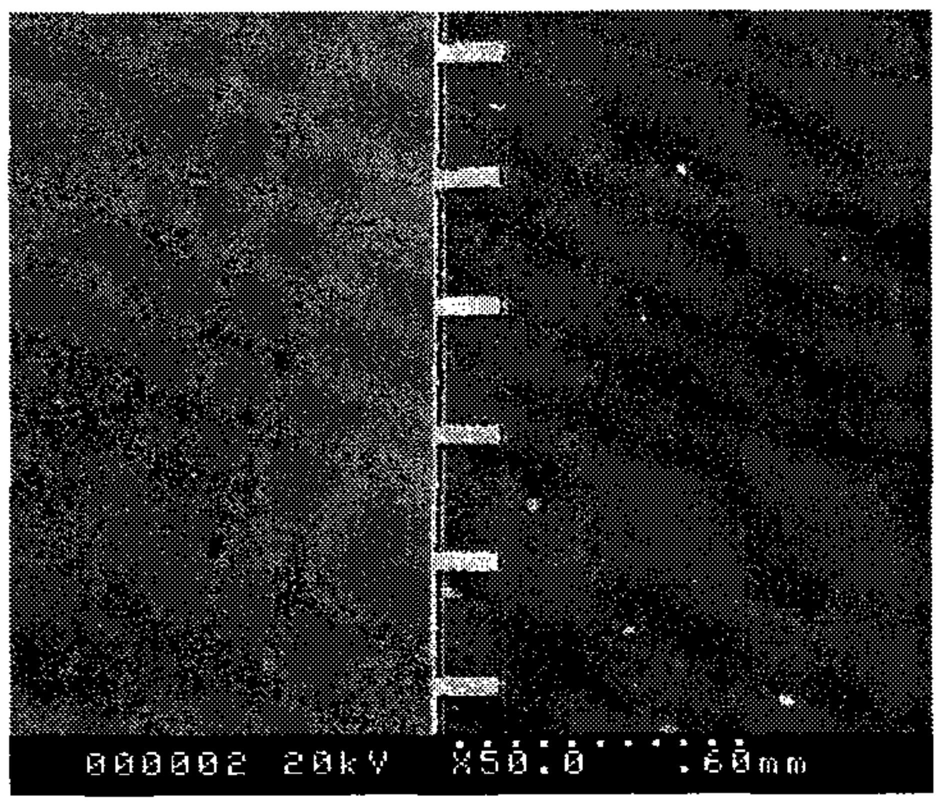
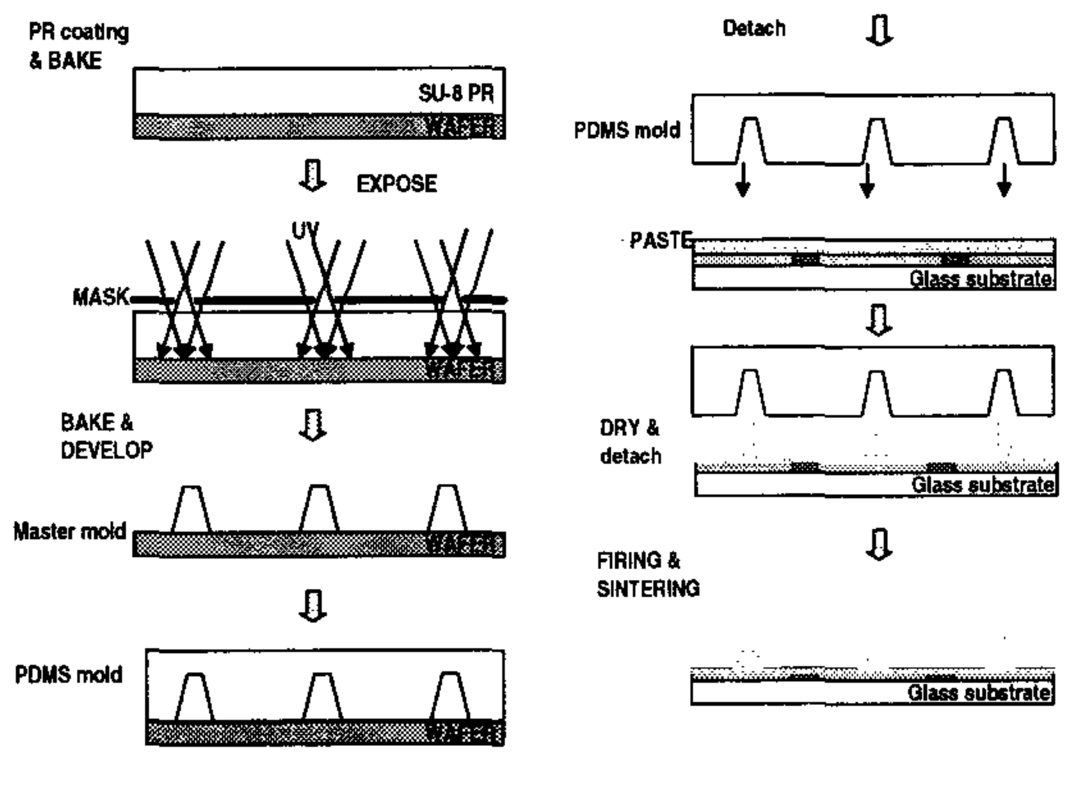


Fig. 1. Morphology of barrier ribs prepared by capillary molding process.

In this study, therefore, an attempt was made to modify the barrier rib morphology using molds with draft angles. The mold was prepared by inclined UV lithography process [8-9]. Several different closed-cell type ribs such as SDR, DelTA and honeycomb were produced by the process.

2. Experimental procedure

Fig 2. shows a schematic illustration of preparing steps involved in mold preparation and capillary molding processes.



(a) (b)

Fig. 2. Schematic illustration of (a)mold preparation and (b) capillary molding processes

The SU-8 photoresist film was inclined to the vertical UV light for patterning and used as a master mold. After the preparation of the master mold, PDMS liquid was coated on the mold and cured at 120℃ for 30 minutes. After the curing, the PDMS molds was removed from the master mold and used as a working mold for the capillary molding process.

3. Results

3.1. Preparation of master mold

Fig. 3 shows the strip master molds prepared by inclined UV lithography process. As noted from Fig. 3, a stripe type master mold with draft angle was formed with well-defined morphology. The draft angle of the sample was 10°.

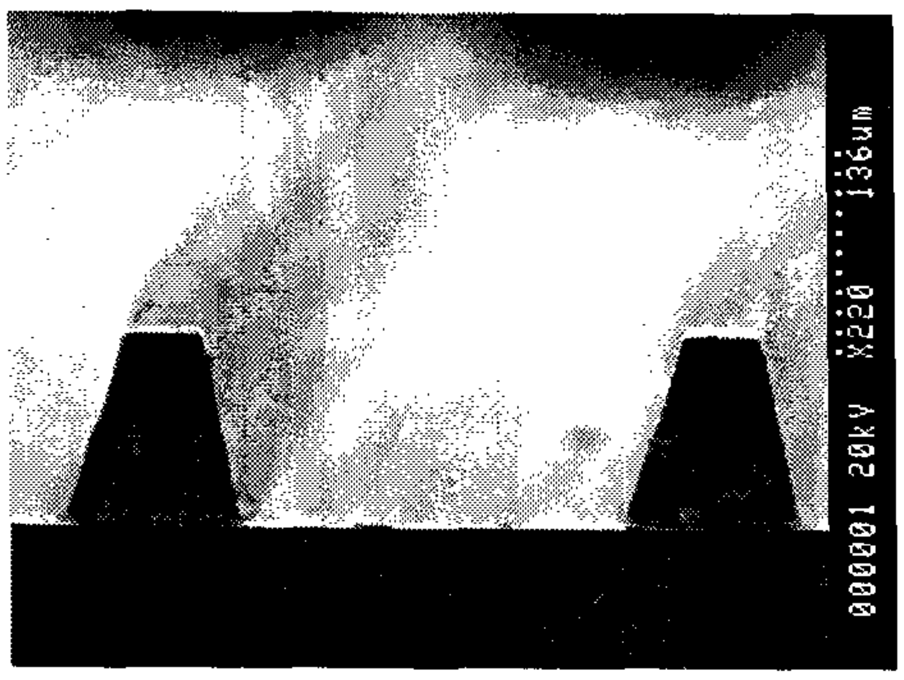


Fig. 3. Master mold for stripe type barrier ribs.

SDR type master mold with the same draft angle was prepared using the same procedure. As noted in Fig. 4, the draft angle was also formed with the mold. For the preparation of the mold, four separate steps of inclined UV exposures were carried out.

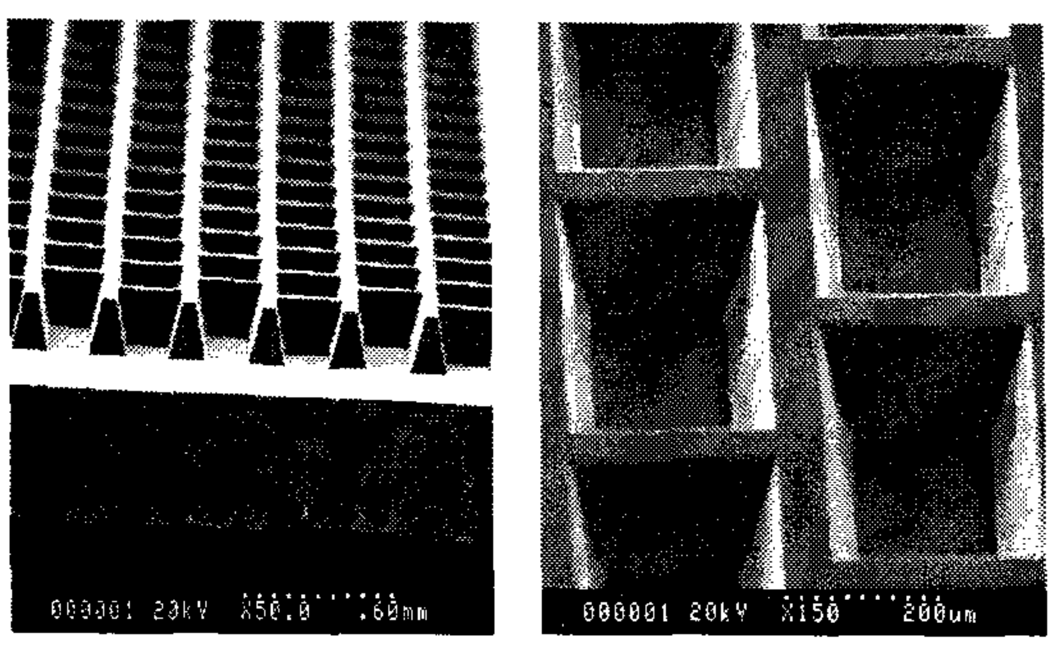


Fig. 4. SEM micrographs of SU-8 master molds of SDR type.

Honeycomb type master mold with the draft angle was also prepared. As illustrated in Fig. 5, well-defined master mold was produced by the inclined UV lithography process.

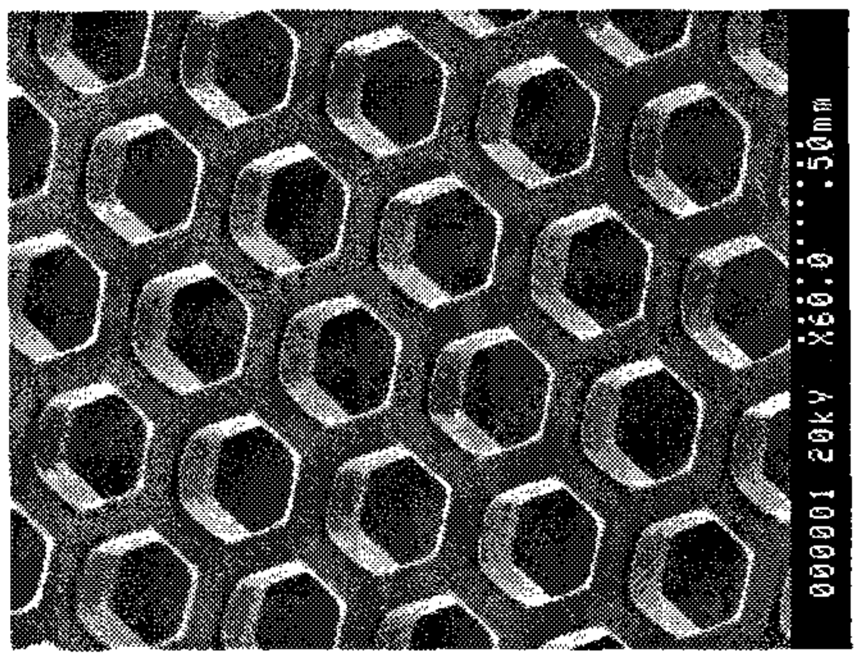


Fig. 5. Morphology of honeycomb type master mold.

Using the master molds, PDMS working molds were prepared following the procedure described in Fig. 2. The capillary molding of the thermally curable paste was also conducted following the experimental procedure described elsewhere in more details[7].

3.2. Morphologies of barrier ribs prepared using mold with draft angle

Fig. 6 shows morphologies of SDR type barrier ribs in (a) cured and (b) sintered states. As noted in the figure, the ribs in cured state are formed according to its original design. The sintering of the cured ribs, however, resulted in the distortion of the ribs. The distortion has been identified to be caused mainly by the shrinkage occurring during sintering step [10].

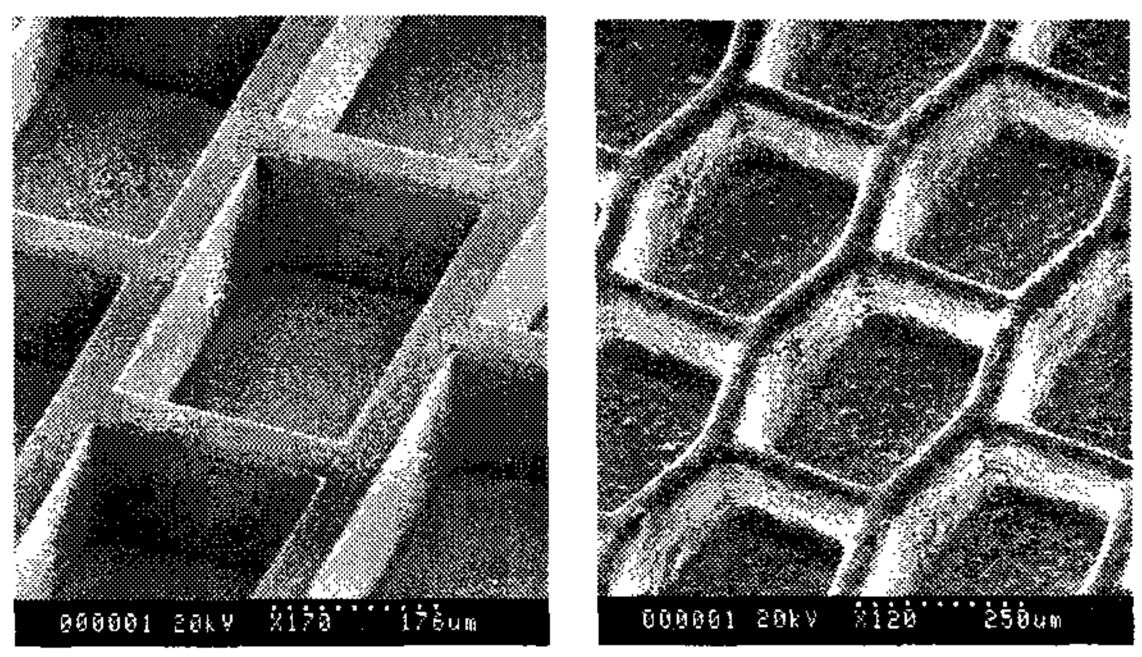


Fig. 6. Morphologies of barrier ribs in (a) cured and (b) sintered states.

In order to reduce the sintering distortion, dimensions of crossing ribs were changed.

Figure 7 shows the morphologies of SDR type barrier ribs after sintering. The crossing ribs thickness was changed from 30 to 50 μm. As noted in the figure, the distortion of the ribs was not affected significantly by the thickness of the crossing ribs. These results suggest that the barrier ribs with anisotropic sintering shrinkage should become distorted during sintering steps.

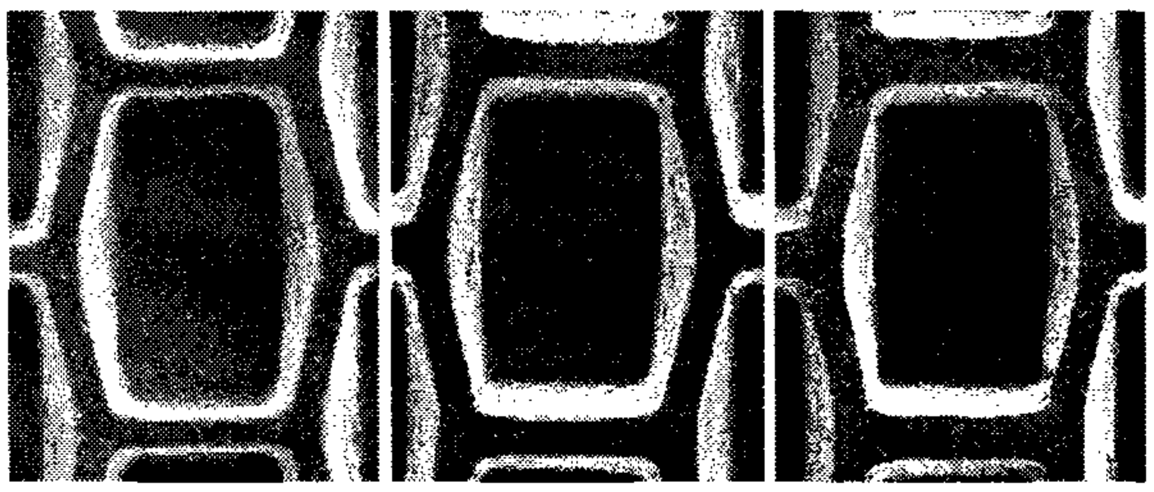


Fig. 7. Effect of crossing bar thickness on the distortion of SDR type barrier ribs.

Among the various closed-cell type barrier ribs, the honeycomb type ribs are of isotropic in sintering shrinkage. At the triple point where three cells meet together, the sintering stress exerted by the each ribs should be equal to each other. Fig. 8 shows the morphologies of honeycomb type barrier ribs in (a) cured and (b) sintered state. As noted in the figure, the morphology of the ribs remained the same after the sintering.

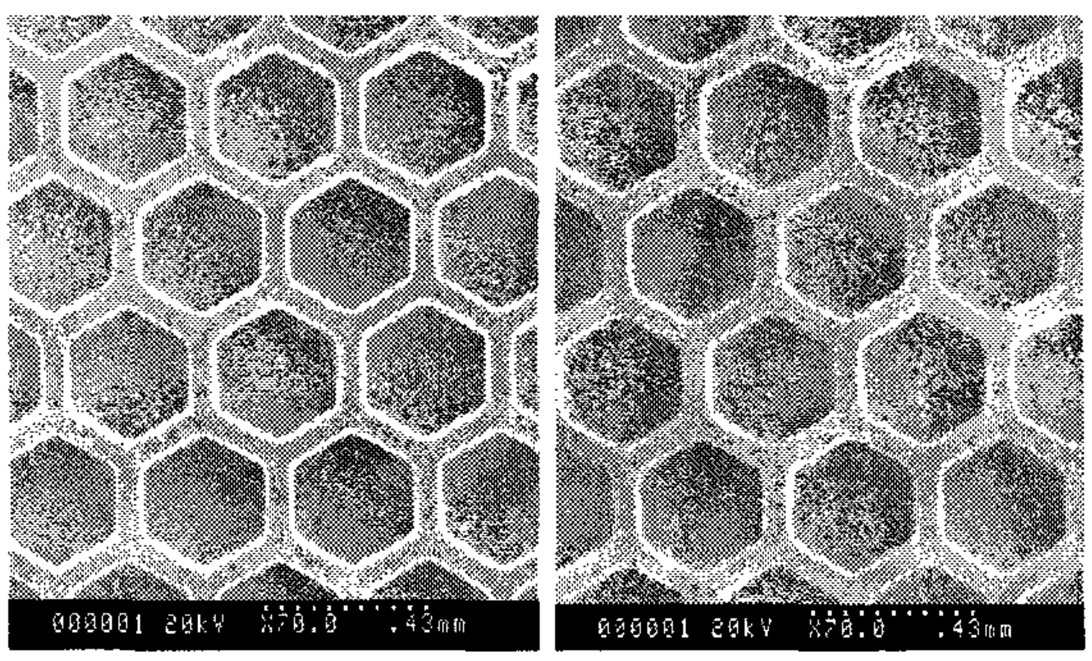


Figure 8. Morphologies of barrier ribs in (a) cured and (b) sintered states.

4. Conclusions

The inclined lithography technique was applied in preparing master mold for the capillary molding process. It was demonstrated that the molds can be fabricated successfully through the process, improving the dimensional stability of the molds. In addition, the closed-cell type ribs with anisotropic shrinkage stress such as SDR type barrier ribs became distorted significantly during sintering step. The morphology of ribs with isotropic sintering stress such as honeycomb type cells was not changed with the sintering step.

4. Acknowledgements

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5. References

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