Fabrication of Self-standing Thin Polystyrene Films with Through Holes by use of Casting Process

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1. Introduction

Self-standing film with through holes can be used as membrane filter. A filter with desired shape holes can be obtained at low cost by using imprint process. For self-standing film fabrication by imprint process, a thin film on a dummy substrate is patterned by imprint process (imprint process), and the patterned film is released from the dummy substrate (release process). The sticking force between thin film and dummy substrate has to be large in the imprint process but it should be extremely small in the release process. It is difficult to satisfy the conflicting requirements for the sticking force. A new process, where water soluble PVA film is used, has been proposed to overcome this problem[1]. However, it was difficult to obtain through holes because holes were covered by thin residual layer produced in imprint process. In this report, self-standing thin film with through holes is fabricated by casting process[2] for PVA pattern.

2. Experimental procedure

The process flow is shown in Fig. 1. A commercial bi-layer film sheet of polyethylene terephthalate (PET) film of 75 μm and polyvinyl alcohol (PVA) film of 30 μm (SO sheet® supplied by AICELLO) is used (Fig. 1(a)). First, the PVA film is patterned by thermal nano-imprint process (T-NIL). The pressure and temperature are 10 MPa and 170 °C, respectively (Fig. 1(b)). The PS resin is spin-coated on the patterned PVA film (Fig. 1(c)). The PS film top is bonded to a doughnut shape Al frame and the PET film is peeled off (Fig. 1(d)). The inner diameter of the Al frame is 5 mm. The PVA pattern is removed in hot water of 70 °C (Fig. 1(e)). The PS film with through holes is obtained (Fig. 1(f)).

3. Results and discussions

Fig. 2 shows PVA pattern after T-NIL. The 2μm square pillar pattern of 3.5 μm height is obtained. The PS resin is spin-coated for fabricating 2 μm thick PS film on a flat Si wafer. It is expected that the PVA pillar of 1.5 μm height appears on the PS film. Fig. 3 shows the PVA pattern after the PS resin spin-coating. The PVA top seems to be appear, but appearing PVA pillar height is about 0.5 μm. The discrepancy from the expected height will be examined. Fig.4 shows the fabricated self-standing PS film with through holes from the PS side. It is found that thin self-standing PS film with through holes is successfully obtained. However, some defects are also found. The magnified PS hall pattern of A is shown in right upper picture of Fig.4. It is clear that a large part of the hall is covered by thin PS film. The defects will be decreased by process improvement.

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[1] N, Sakamoto et al. ; MNC 2016 (Kyoto, Japan, Nov. 2016), 10P-7-114L.
[2] Y. Hirai et al. : Microelectron. Eng., **78-79**, 641 (2005).

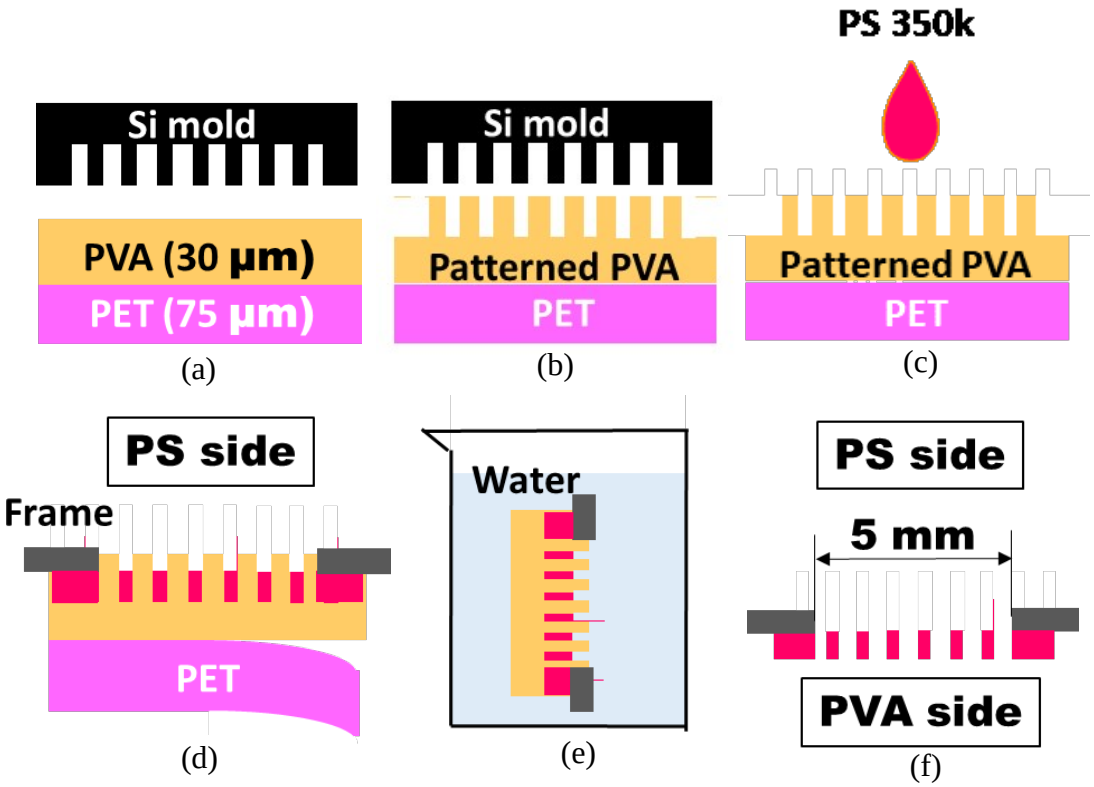

Fig. 1 Fabrication process of self-standing PS film by casting process

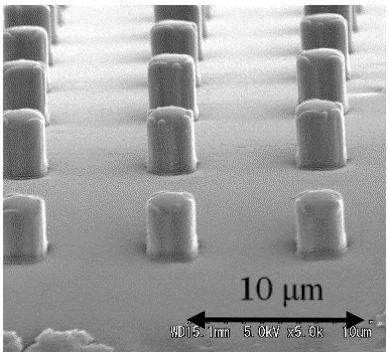

Fig. 2 Fabricated PVA pattern by thermal nano-imprint process.

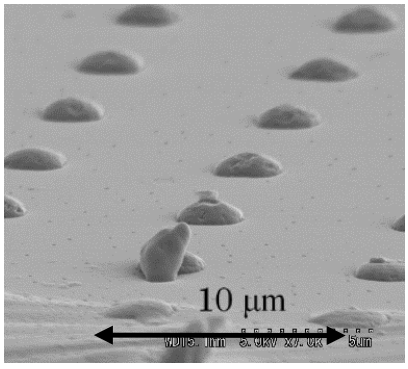

Fig. 3 PVA pattern after PS coating.

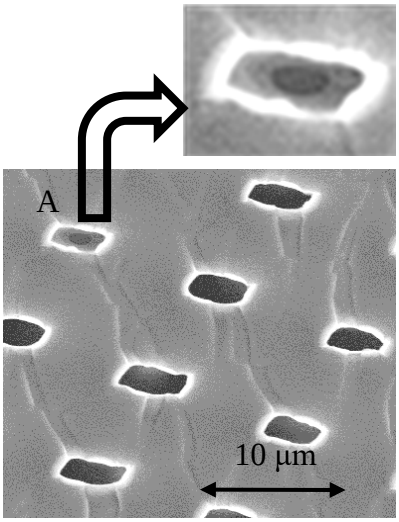

Fig. 4 Fabricated self-standing PS film