# Surface Adhesion Control of Patterned Perfluoro Polymer for Release Technology in μTAS Fabrication Process

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Recently, many kinds of Micro Total Analysis Systems (μTAS) devices and balloon devices have been developed. These devices utilize PDMS expansion and deformation phenomenon, and use fluidic channels to supply air or fluids. Combination of roof layers and grooved substrates is typically used in forming micro fluidic channels. In this study, we use patterned perfluoro polymer (CYTOP®, CTL809-A, Asahi glass co.ltd). CYTOP® is a kind of amorphous perfluoro polymer that can be formed super hydrophobic thin film on a substrate by spin-coating and curing. CYTOP® has strong adhesion to most of the base substrate materials. On the other hand, most of the adhesive materials are not easily bonded to the surface of CYTOP®. Thus, the release process presently proposed is preferably robust in forming fluidic channels for μTAS structures, will be formed using various kinds of substrate materials and adhesive materials. The fluidic channel which is formed by our proposed process has the feature that can be adapated the opened state and the perfectly closed state by switching supplied pressure. The channel formed by the release process has a potential for switching device for fluids in μTAS, for example a diaphragm valve.

Figure 1 shows a balloon device composition. Figure 1(a) is an example of conventional structure and Figure 1(b) is a proposed stcucture of the device using patterned poor adhesive layer. CYTOP® can be patterned by dry etching using patterned metal mask. Some kinds of the fabrication process cause damages to the surface of the perfluoro polymer layer. Thus, it is necessary to avoid chemical and physical damages during the process in order to keep poor adhesion of patterned perfluoro polymer.

We focused on the metal mask material for dry etching and added post-annealing after patterning CYTOP® to decrease damages. Experimental results of tensile adhesive strength are shown in Fig. 2. Tensile adhesive strength increased at all samples after patterning. The poor adhesiveness can be realized by post-annealing at higher than glass transient temperature. In case of using Cu with post-annealing at 110˚C, the increase of tensile adhesive was lower than patterned CYTOP® using other mask materials with post-annealing at 230˚C. To use Cu mask can decrease post-annealing temperature for the release process. Conditions of the patterning process was determined based on experimental results. Evaporated copper was used as an etching mask. CYTOP® layer was post-annealed at higher temperatures than 110 ˚C for 1 hour. We tried to fabricate and demonstrate a balloon device on a flexible polyimide film by optimized release process. A photograph of balloons before operation is shown in Fig. 3(a). Fig. 3(b) shows the patterned hydrophobic region on a substrate (polyimide film) and a roof layer (silicon rubber film) after peeling off by force. A roof layer bonded strongly outside of the region of the patterned CYTOP®, and fluidic channels can be released succcessfuly.

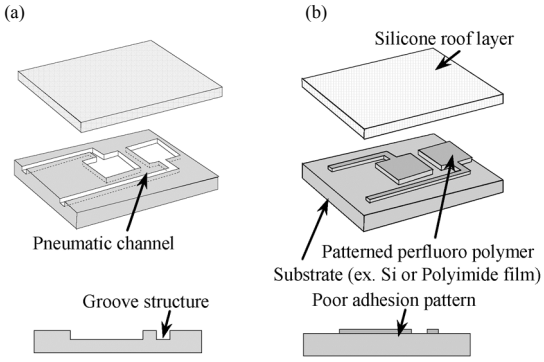


Fig. 1. Construction of fluidic channels. (a) Conventional formation method of fluidic channels by bonding grooved substrates, (b) Our proposed formation method by using patterned perfluoro polymer.

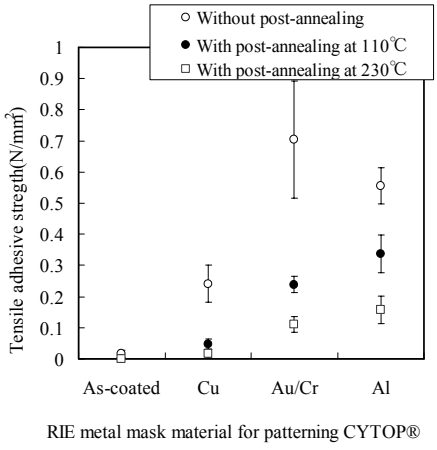


Fig. 2. Comparison of tensile adhesive strength.

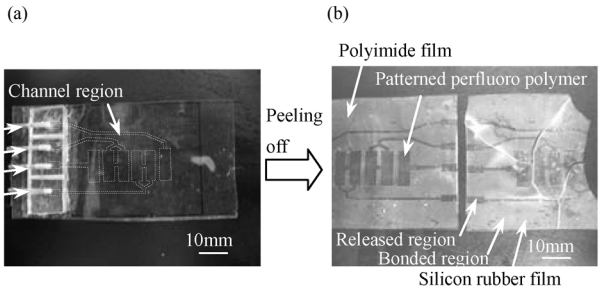


Fig. 3. Photographs of a balloon device formed by release process. (a) Balloon device before operation, (b) The patterned hydrophobic region on a substrate (polyimide film) and a roof layer (silicon rubber film) after peeling off by force.