Abstract

We present a novel fabrication method for patterning PDMS thin films on solid surfaces. The method allows microstructures with precise lateral dimensions and heights to be formed using PDMS. We have applied this technology to form microfluidic channel units, reaction chambers, and micro elastic gaskets. This new fabrication method could potentially give rise to an efficient and reliable approach of constructing microfluidic systems.

Keywords: PDMS, microfluidic

1. Introduction

Polydimethylsiloxane (PDMS) elastomer is widely used in microfluidic applications to form components such as channels, valves, and diaphragms [1,2]. The PDMS material offers many advantages. It is transparent and biocompatible. It can be easily processed by molding and acquired for low costs. It is elastic and can form fluid seals effectively.

PDMS is commonly used as a bulk material [3]. The predominant fabrication process associated with PDMS is bulk molding. It is previously impossible to form fine features made of PDMS with controlled lateral dimensions and heights (e.g., less than 10 µm) on solid surfaces (e.g., silicon or glass).

There are two major causes to this deficiency. First, PDMS is not photodefinition and cannot be photolithographically patterned like photoresist. Secondly, PDMS pre-polymer is viscous. It is impossible to form thin films of PDMS using spin coating, or any other method we know of. Earlier work showed that even when spinning wafers at 8,000 rpm, the resultant PDMS thickness is greater than...
2. Method for PDMS Patterning

The principle of the PDMS patterning process is discussed in the following (see Fig. 1). A photoresist layer is first deposited on top of a solid substrate (e.g., glass or silicon) and patterned by using conventional lithography process. We pour a PDMS pre-polymer solution (in the form of a viscous liquid) over the substrate surface. A flat and smooth blade is used to traverse the substrate surface while maintaining contact with the top surface of the photoresist layer. Excessive PDMS pre-polymer is removed, leaving PDMS only in recessed regions between protruding photoresist molds. After the remaining PDMS is thermally cured, the photoresist mold is removed selectively by using acetone. The height of the resultant PDMS pattern corresponds to the thickness of the photoresist. Figure 2 shows an SEM micrograph of parallel PDMS lines that are 50 μm wide and 5 μm tall.

3. Applications

Based on this PDMS patterning technique, we developed a method to form microfluidic channels (Fig. 3). Patterned PDMS form protruding ridges that define boundaries (banks) of fluid channels on one substrate piece (labeled bottom substrate in Fig. 3a). A top substrate piece is then pressed against the bottom substrate, slightly deforming the PDMS ridges and forming enclosed flow channels (Fig. 3b). PDMS patterns for fluid channels are shown in Fig. 4. Pressure-driven channel flow was demonstrated (Fig. 5). We have found out that the formed PDMS channel can flow water-based solutions without treating the PDMS surface to be hydrophilic. The bulk PDMS channel that is being widely used has to be treated with such as oxygen plasma to