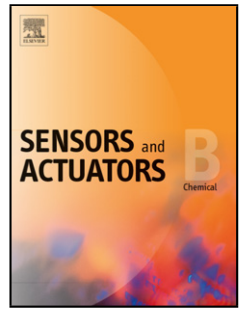

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Fabrication of lateral porous silicon membranes for planar microfluidics by means of ion implantation

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Highlights

- A process for integrating porous silicon membranes in planar fluidics is proposed.
- The fabrication method is based on ion implantation and local anodization.
- The dead-end filtration capability of the fabricated membranes is demonstrated.

Abstract

We introduce a new fabrication method based on ion implantation to create lateral porous silicon membranes and integrate them into planar microfluidic devices. Our proposed method relies on the fact that the formation of porous silicon by anodization highly depends on the dopant type and concentration, which can be manipulated by ion implantation. In order to confine the porosification at desired locations within silicon steps bridging microchannels, we use boron and phosphorus implantation to respectively create a p++ layer buried in an n-type silicon substrate, and a protective n-type surficial layer. The use of a metal electrode patterned onto the silicon step for current injection during anodization enables pores to propagate laterally during the membrane formation. The optimal implantation doses and energies leading to the required boron and phosphorus profiles are determined by means of process simulation and further confirmed by SIMS analysis. We demonstrate that the proposed fabrication process leads to the creation of lateral porous silicon membranes with open-ended pores adequately bridging microchannels and that we are able to manipulate the pore size (~3-30 nm) and membrane porosity (~15-65 %) by adjusting the current density during anodization. The adequate dead-end filtration capability of the fabricated membranes was tested and demonstrates the interest of the presented fabrication process for microfluidic applications.

Keywords
Porous silicon; Ion implantation; Filtration; Microfluidics; Lab-on-a-chip

1 Introduction

Porous membranes are of great interest for on-chip sample preparation and analysis since they enable size and charge-based molecule separation [1, 2], but also molecule pre-concentration by ion concentration polarization [3-5]. Fabricating and integrating a membrane with well-defined pore size and shape is challenging because, as the feature size decreases, the choice of fabrication approaches is limited and the control of membrane characteristics becomes difficult [6]. Arrays of nanochannel fabricated by various nanomachining techniques provide a route to obtain membranes with controllable properties, but the resulting porosity is relatively low and so is the surface area and throughput. Membranes directly created from porous materials can tackle these limitations [7, 8]. Out of the various material available to constitute porous membranes, porous silicon offers many advantages: the process of creating