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A PDMS-based balloon-type implantable drug delivery device

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***Abstract*— Various drug delivery implants have been developed to allow targeted and localized drug delivery by improving the drug bioavailability via controlled release over an extended period of time. However, initial burst, onset time, membrane rupture, conformal contact with tissue, tissue damage and foreign body responses are still the limitations of the existing drug delivery implants. Here, we propose the fabrication method of a soft and flexible PDMS-based balloon-type implantable drug delivery device for a nearly zero-order controlled release of drug.**

I. INTRODUCTION

Oral, transdermal, and intravenous administrations of drugs are the most popular methods of drug delivery. However, first- pass metabolism, degradation in the stomach, poor bioviability and patient compliance are the potential disadvantages[1]. With the advancement in micro and nano-technology, drug delivery implants have emerged as a potential alternative to conventional administration of drugs, for a sustained and controlled release of drugs to make the existing therapies more efficient with minimal side effects[2]. Nevertheless, initial burst, membrane rupture, onset time, non-conformal contact with biological tissues, and foreign body responses needs to be minimized. Here, we propose the fabrication of a soft and flexible PDMS-based balloon- type implantable drug delivery device for a long-term controlled release of drugs to minimize the initial burst, onset time, risk of membrane rupture, tissue damage, and better conformal contact with biological tissues.

II. FABRICATION AND RESULTS

The fabrication of a soft implantable device is illustrated in Fig.1(a). The device is composed of four layers: the bottom PDMS layer, intermediate chlorinated poly(p-xylylene) (parylene C) pattern, top PDMS layer, and final parylene C pattern. To fabricate the device, parylene C was deposited on a substrate as a sacrificial layer followed by spin coating the bottom PDMS layer. For selective bonding[3], the intermediate parylene C layer was deposited using a reverse PET mask, and after parylene C deposition, the PET mask was detached from the bottom PDMS layer, leaving behind the patterned parylene C. The top PDMS membrane was fabricated separately, which acts as a semi-permeable membrane for controlled release of a drug. For selective bonding of the top and bottom layers of PDMS, both surfaces were treated with N_2/O_2 plasma for 1 minute. Then, the two layers were bonded together manually using rubber roller to avoid trapped bubbles. The intermediate parylene C patterned area remained un-bonded. To increase the bonding strength, the device was cured in an oven for 10 secs at 80°C followed by the deposition of the final parylene C layer on the non-bonded area to prevent the back diffusion of a drug into the PDMS layers. After the fabrication of the device in a 2D plane, fluid injection into the non-bonded area turned it into a 3D balloon type reservoir as shown in Fig.1(b). We also performed the device characterization based on the thickness of PDMS membrane to investigate the release kinetics, resulting in nearly zero-order release up to 3-5 months (data not shown).

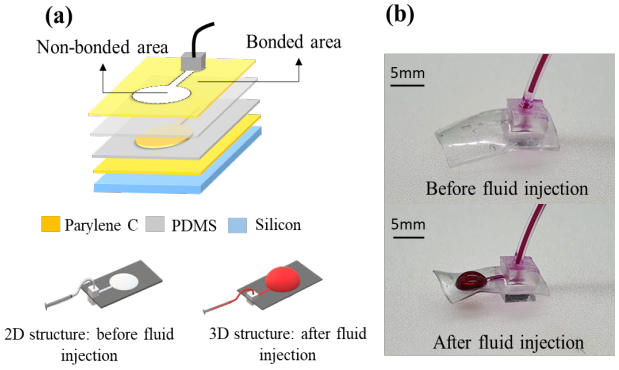

Figure 1. Soft and flexible balloon-type implantable drug delivery device: (a) schematics of the layers that compose the device and the device before and after fluid injection, and (b) fabricated device filled with a liquid.

III. CONCLUSION

We successfully fabricated the soft and flexible PDMS-based balloon-type implantable drug delivery device for the controlled release of a drug. To evaluate the device performance, further *in-vitro* characterization is needed to see the effect of mixing ratio of semi-permeable PDMS membrane on the release kinetics of the device. Also, *in-vivo* experiments are needed as a further study.

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