A review of my learnings on PDMS and environmental applications

Briefa Synops

May 2019

1 Introduction

The methodology uses PDMS [11, 2]and explains how to create PDMS but the main application is to environmental questions in water and soil. For this purpose, microstructures modeled on real micro-scale geometries are used [1, 10].

2 PDMS

For PDMS manufacturing, the following is from a review by [4] that outlines the steps in PDMS production: One of the most widely used materials in sot lithography is PDMS, which is an elastomeric material. It is a liquid that is polymerized after mixing with a curing agent... Usually, it consists of the following steps: (i) the network of micromodel chan-nels is created digitally and printed on a transparency, which is used as a mask in the next step; (ii) a silicon or glass wafer is spin-coated with photoresist (positive or negative depending on the desired depth) to create a patterned silicon or glass wafer (called a master) by using photo-lithography; (iii) the master wafer is put in a petri dish and a mixture of liquid PDMS and curing agent is prepared, which is then poured over the master wafer in the petri dish; (iv) the polymer is degassed under vacuum and then cured; (v) water curing, the polymer is peeled from the master; and (vi) the PDMS slab with the desired network is placed on a precured thin slab of PDMS to close the network and exposed to ion plasma so that bonding can take place. This technique is explained in [7] which describes the EcoChip system:

> The EcoChip system is adaptable to the needs of an individual experiment. New masters can be created relatively easily,

> and once a master is fabricated, additional exactly replicated devices can be cast as needed. The flow module is simple to use, requires no special equipment or complex connections, and can be modeled as a simple falling head pressure-driven flow system.

Additional method papers include the addition of electrodes [3]:

> Electrode microfabrication methods typically pattern metal electrodes onto a flat substrate. However, when anode and cathode are both positioned on the bottom of a microfluidic channel, the electric field is not uniform with channel depth.

3 Environmental pollution

Heavy metals and other pollutants enter aquatic environments via many routes, including atmospheric deposition, surface runoff, and direct discharge via effluent streams according to Ma et al. This is one of the points in [8] which finds:

> For many of the PAHs investigated, stormwater runoff is the most important input pathway to the Harbor. Stormwater runoff contributes between 17 and 46% of total loads for different PAH compounds, with the higher MW PAHs contributing a slightly greater proportion to total inputs to the Harbor. Recovery of par- ticulate matter from urban pavement runoff is high, in one study exceeding 90% per event (Sansalone and Kim, 2008), so it is not surprising that the high-MW PAHs, which tend to be particle bound, are prevalent in stormwater.

What happens once contaminants enter the soil is discussed in [9]:

> Field and laboratory studies have shown that by increasing intervals of contaminant contact with soils and sediments longer periods of time are required to biodegrade an equivalent amount of contaminant, and the fraction of the total contaminant mass supplied to the system that cannot be biodegraded is increased.

4 Conclusion

Interesting techniques and applications were found that are very much worth pursuing. Other good learning papers are [6] and [5].

5 References

References

[1] J. Deng, E. P. Orner, J. F. Chau, E. M. Anderson, A. L. Kadilak, R. L. Rubinstein, G. M. Bouchillon, R. A. Goodwin, D. J. Gage, and L. M. Shor. Synergistic effects of soil microstructure and bacterial eps on drying rate in emulated soil micromodels. *Soil Biology and Biochemistry*, 83:116–124, 2015.

[2] T. Fujii. Pdms-based microfluidic devices for biomedical applications. *Microelectronic Engineering*, 61:907–914, 2002.

[3] A. L. Kadilak, Y. Liu, S. Shrestha, J. R. Bernard, W. E. Mustain, and L. M. Shor. Selective deposition of chemically-bonded gold electrodes onto pdms microchannel side walls. *Journal of Electroanalytical Chemistry*, 727:141–147, 2014.

[4] N. Karadimitriou and S. Hassanizadeh. A review of micromodels and their use in two-phase flow studies. *Vadose Zone Journal*, 11(3):vzj2011–0072, 2012.

[5] E. Leclerc, Y. Sakai, and T. Fujii. Cell culture in 3-dimensional microfluidic structure of pdms (polydimethylsiloxane). *Biomedical microdevices*, 5(2):109–114, 2003.

[6] Y. Lu, B. Lin, and J. Qin. Patterned paper as a low-cost, flexible substrate for rapid prototyping of pdms microdevices via liquid molding. *Analytical chemistry*, 83(5):1830–1835, 2011.

[7] D. A. Markov, P. C. Samson, D. K. Schaffer, A. Dhummakupt, J. P. Wikswo, and L. M. Shor. *Window on a microworld: Simple microfluidic systems for studying microbial transport in porous media.* MyJoVE Corporation, 2016.

[8] L. A. Rodenburg, S. N. Valle, M. A. Panero, G. R. Muñoz, and L. M. Shor. Mass balances on selected polycyclic aromatic hydrocarbons in the new york–new jersey harbor. *Journal of environmental quality*, 39(2):642–653, 2010.

[9] L. M. Shor and D. S. Kosson. Bioavailability of organic contaminants in soils. In *Bioremediation*, pages 15–43. Springer, 2000.

[10] L. M. Shor, D. S. Kosson, K. J. Rockne, L. Y. Young, and G. L. Taghon. Combined effects of contaminant desorption and toxicity on risk from pah contaminated sediments. *Risk Analysis: An International Journal*, 24(5):1109–1120, 2004.

[11] M. W. Toepke and D. J. Beebe. Pdms absorption of small molecules and consequences in microfluidic applications. *Lab on a Chip*, 6(12):1484–1486, 2006.