MICROFLUIDIC DEVICE FOR ENHANCING CAPILLARY-DRIVEN FLOW IN MICROCHANNELS

IITM Technology Available for Licensing

Problem Statement

- Capillary flow in thin tubes is a useful phenomenon that can be utilized to **enhance flow of fluids in microfluidic channels** without the need for external energy.
- Extent of capillary rise **depends on the radius of the meniscus of the rising liquid** and the **diameter of the micro-channe**l, This limits the capillary rise in tubes having a fixed diameter.
- Enhancing capillary rise would require **reducing tube diameters**; however, this may reduce fluid flow.
- There is a need for a capillary rise method that enhances capillary rise based on the **principle of elasto-capillarity to enhance capillary rise and flow**.

Intellectual Property

- IITM IDF Ref. **1257**
- **IN 366293 - Patent Granted**

TRL (Technology Readiness Level)

TRL - 3: Experimental proof of concept

Technology Category/ Market

Category-Micro & Nano Technologies

Industry Classification:

- **NIC (2008)- 32504** - Manufacture of bone plates and screws, syringes, needles, catheters, Cannulae etc**; 42904-** Construction of outdoor sports facilities**; 01612-** Operation of agricultural irrigation equipment**; 26511-** Manufacture of physical properties testing and inspection equipment; **26204-** Manufacture of printers, scanners etc
- **NAICS (2022)- 339112** Surgical and Medical Instrument Manufacturing**; 334516-** Analytical Laboratory Instrument Manufacturing**; 221310** Water Supply and Irrigation Systems.

Applications- Flow enhancing vascular implants, Subsurface irrigation systems, Microfluidic sensors, polymer micro-devices, inkjet printers, microfabs etc.

Market Drivers-

Cardiovascular implants market projected to reach $34.59 billion by 2028, reflecting a CAGR of 6.6**%** ; The**; Global Microfluidics market** projected to reach USD 117.13 billion by 2031, growing at a CAGR of 23.98%

Research Lab

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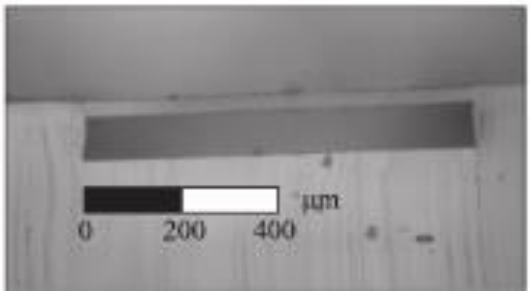

Figure: Optical micrograph of the cross section of a deformable channel fabricated in polydimethylsiloxane (PDMS)

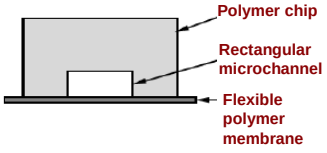

Figure: Meniscus shape in identical (a) rigid and (b) deformable channel fabricated in PDMS

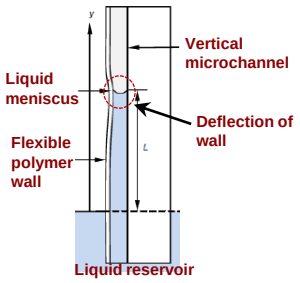

Figure: Capillary rise of liquid with deflection of wall under capillary pressure

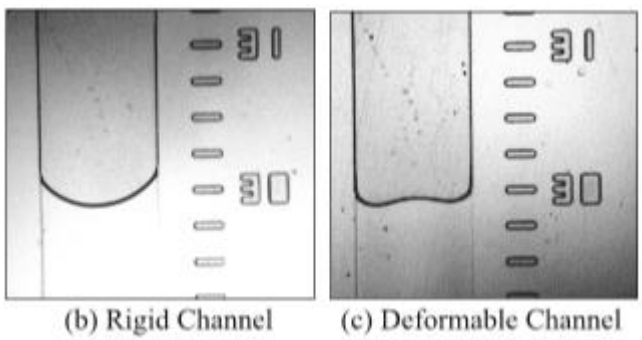

Figure: Meniscus shape in identical (a) rigid and (b) deformable channel fabricated in PDMS

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Technology

1. The invention uses a polymer membrane in microchannel walls to enhance capillary action.
2. The flexible polymer membrane is fabricated using soft lithography and a polymer microchip is bonded to it using oxygen-plasma bonding to create a micro-channel.
3. The capillary pressure drop in the channel is enhanced by the deformation of the flexible membrane wall into the channel reducing the average curvature of the meniscus
4. Enhanced capillary drop results in increase in meniscus height for flexible wall channels when compared to rigid wall channels.
5. Capillary rise height was plotted as a function of aspect ratio of a 1 mm wide micro-channel with 60 micron thick flexible PDMS wall

Key Features / Value Proposition

- The method of using a flexible polymer membrane in micro-channels enhances capillary flow when compared to micro-channels with only rigid walls.
- The experimental data closely follows the theoretically predicted data for capillary flow in flexible wall micro-channels.
- The use of PDMS a bio-compatible polymer in fabricating the flexible membrane for the microchannel enables its application in implants for humans.
- Elasto-capillarity based micro channels enable steady and predictable flows enabling their application in sub-surface irrigation systems with reduced evaporative losses. Whereas, traditional sprinkler irrigation for lawns and turfs suffers from wastage due to evaporation.

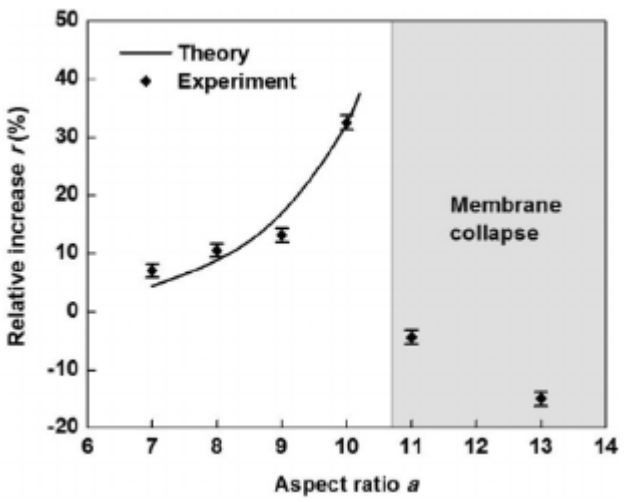

Figure: Experimental and theoretical relative increase in capillary rise height of propane-1,2-diol in vertical deformable microchannel . The theoretical curve closely follows the experimental data

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