Microfluid Nanofluid
DOI 10.1007/s10404-013-1293-7

SHORT COMMUNICATION

A novel filtration method integrated on centrifugal microfluidic devices

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Received: 24 July 2013 / Accepted: 11 November 2013

Abstract A method has been developed that integrates filters directly into centrifugal microfluidic devices. This technique is suitable for both rapid prototyping and commercial applications. Commercially available filter paper was sealed into the centrifugal microfluidic device with a simple manual fabrication procedure. The method was validated using soil slurry in water and a variety of filter papers with pore sizes ranging from 0.7 to 11 μm. Filtration times of 4 s to several minutes were obtained for 100 μL samples depending on the type of filter paper and rotation rate utilized. The validity of the method was demonstrated by assessing the amount of light lost due to the scatter or absorption caused by particles in the filtered sample while the device was in motion. Filtration and sedimentation were compared and after 30 min of centrifugation, sedimentation had not removed particles as well as filtration. This technique opens up centrifugal microfluidic devices to a wide range of samples.

Keywords Filtration · Sedimentation · Centrifugal · Microfluidic · Environmental analysis · Three-dimensional flow

1 Introduction

The desire to miniaturize, accelerate, and increase throughput of chemical analyses has been a growing concern in the last several decades. One popular solution to this challenge is the micro total analysis system (known as μTAS), which incorporates all or most of the steps of analysis into one device with internal dimensions in the micro- or nanometre range. Microfluidic devices provide a wide range of operations such as liquid transport, metering, valving, mixing, separation, reagent storage and release, incubation, and many others (Mark et al. 2010; Ríos and Zougagh 2013). One unique subcategory of μTAS is centrifugal microfluidics (also known as 'Lab-on-a-CD') that primarily relies on centrifugal force to initiate liquid flow in the device, which is most often CD-shaped (Gorkin et al. 2010; Madou et al. 2006). The device is mounted on a motor, and the force applied by spinning the device at various angular velocities is utilized to move the liquid, thereby eliminating the need for connections to pumps (Duffy et al. 1999; Mark et al. 2010; Zoval et al. 2007; Zoval and Madou 2004). Along with the advantages associated with microfluidics in general, such as reduction in reagent, cost, and time (Arora et al. 2010; Ríos et al. 2012), centrifugal microfluidics also offers radial symmetry inherent to the geometry of the device. This symmetry allows large numbers of replicate systems to be created and run on the same device simultaneously (Duffy et al. 1999).

One challenge faced when analysing environmental samples on microfluidic devices can be the presence of particulates that can cause serious problems for the operation of the device. The common solution to this problem is to filter the samples with bench scale methods prior to injection into the device. Filtration prior to injection may be achieved by a variety of methods; however, many require much larger volumes for filtration than are needed on the microfluidic device. As Ríos and Zougagh (2013) discussed in their review of microfluidics, two approaches have been used to solve the particulate problem, structural-based filtration and diffusion-based filtration. Both structural-based

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Published online: 24 November 2013