Controlling Spatial Concentrations in Microchannels Using Embedded Cavities

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A prevailing theme in microfluidics is the idea of a lab-on-a-chip or integrated device containing individual functional components, together capable of performing a specific task. While countless exciting advances have been made in the field, the idea of on-chip chemical storage has been largely neglected. The on-chip storage and controlled transport of chemicals incorporated into lab-on-a-chip systems could make them even more fully integrated. By placing a cavity filled with reagents of interest in a microchannel, its contents can be both stored and released in a controlled way when exposed to flowing solution. This dual role of the cavity could aid in the simplicity of lab-on-a-chip systems by storing many of the chemicals needed for their operation on-chip. The use of cavities as components capable of controlling chemical concentrations in microchannels has been examined. Microchannels composed of polydimethylsiloxane (PDMS) and glass were fabricated with one wall that contained a cavity in a rectangular, circular, or triangular shape. The cavities were filled with a viscous solution containing a fluorescent indicator and were exposed to flowing buffer solutions. Release of the fluorescent indicator was imaged using a CCD camera. Different spatial distributions of the indicator were observed for each of the different cavity shapes. These results demonstrate one way that cavities can be used to control spatial concentrations in microchannels. The controlled release and distribution of chemical concentrations from cavities embedded in microchannels could be used for many lab-on-a-chip applications and would be of particular value for single-use devices because the technique can be used to store reagents.