Summary

A research team led by Professor John Wikswo of Vanderbilt University has developed low-cost, small-volume, metering peristaltic micro pumps and micro valves. They can be utilized either as a stand-alone device, or incorporated into microfluidic subsystems for research instruments or miniaturized point-of-care instruments, Lab on a Chip devices, and disposable fluid delivery cartridges. The key advantage of this pump is that it can deliver flow rates as low as a few hundred nL/min to tens of μL/min against pressure heads as high as 20 psi, at approximately 1/10th the cost of stand-alone commercial syringe and peristaltic pumps. The RPV can implement complicated fluid control protocols and fluidic mixing without bulky pneumatic controllers. Both the RPPM and RPV can be readily customized for specific applications.

Addressed Need

A major challenge in translating microfluidic and Lab-on-a Chip technologies into marketable devices is the controlled movement of small volumes of fluids. The present RPPM and RPV technologies provide a low cost solution to this problem. The specific attractive attributes of this technology are the need for minimal hardware, almost no dead space, the absence of microfluidic interfaces, low time lag and most importantly very low cost.

Technology Description

While most peristaltic pumps squeeze a tube by driving rollers around a bent piece of flexible tubing, the Vanderbilt RPPM rolls caged balls over a microfluidic channel the same way one would roll an apple in a circle between one’s hands.

Traveling peristaltic compression of a fluid-filled channel is created by the rotational translation of steel balls (4) guided by a floating, circular plastic cage (3) to form a simple thrust bearing. The motor-driven disk (1) has an elastomer washer (2) matched to the elastomer layer (5) that seals the microfluidic channel (6) in the microfluidic device (7). The low-cost pump motor and drive head (1-4) can be fabricated distinct from the disposable, sterilizable microfluidic cartridge (5-7). Configuration of the channels radially rather than circumferentially converts the device into a Rotary Planar Valve (RPV) that can be used to select between different on-chip flow paths at much lower cost than competing technologies.

Unique Properties and Applications

» RPPMs provide microfluidic control capability at ~1/10th the cost of standard commercial peristaltic microfluidic systems
» The microfluidic design, pump dimensions and rates, and valve configurations can be readily customized for specific applications
» RPPMs and RPVs can be readily incorporated directly into a disposable microfluidic chip
» No pneumatic connection is required to control either the RPPM or RPV. The motors in the devices can be powered by a small rechargeable battery

Technology Development Status

» Several versions of RPPMs have been implemented with NEMA 17, 11, and 8 stepper motors and a miniature DC-gearhead motor for $150 or less
» RPPMs have been tested without failure for over 2.5 million revolutions

Intellectual Property Status

» PCT application (WO2012/048261) filed in 2011
» 3 provisional applications filed in 2012 for RPPM accessory devices
» Inventor webpage and publications: http://www.vanderbilt.edu/viibre