Micro-Magnetomechanical Systems (MAMS) for next generation microfluidic chips

Kari Ullakko

LUT University
School of Engineering Science
Finland
kari.ullakko@lut.fi

Micro-electromechanical systems (MEMS) are widely used in microfluidics. In this presentation, a new concept of micro-magnetomechanical systems (MAMS) made from an adaptive MSM (Magnetic Shape Memory) material will be introduced and their applications for microfluidics will be presented. MEMS devices are made from functional materials like silicon or polymers. MAMS will represent the next generation of microfluidic devices in which properly treated zones in the adaptive material act as valves, pumps or manifolds, and other zones are prepared to be fluid channels, chambers or the body of the microfluidic chip. In this presentation, concepts of making the MAMS devices by additive manufacturing from MSM material powder and a by laser ablation technique from MSM material wafers will be presented. Microfluidic MAMS devices enable more complex geometrical designs and higher functionality than current MEMS devices. MSM materials are suitable for the MAMS microfluidics due to their ultrafast actuation of over 2 million m/s^2 and large magnetic-field-induced strains up to 11%. Applying a local magnetic field to a zone of the MAMS chip creates a shrinkage in that zone. This shrinkage can be driven by the magnetic field with a speed of several m/s along the zone. The shrinkages can carry fluids and they can be used for dispensing or pumping fluids at a pressure up to 9 bars. Advantage of these pumps is wireless operation. Results on pumping of water, glycerine and air will be presented. Ultrafast dynamics of the microfluidic MAMS devices is expected to have great application potential in biomedicine.