Batch Fabrication of SMA-Actuated Polymer Microvalves

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Shape memory alloys are particularly attractive for microsystems applications due to their high energy densities and favourable scaling behaviour. However, their introduction into novel microsystems products is hampered by various technological constraints and process incompatibilities. Consequently, many technology combinations promising novel functionality in various applications cannot be realized today. In order to overcome these problems, new technologies for transfer bonding and hybrid integration need to be developed being compatible to batch fabrication.

In the present study, a new generation of polymer microvalves is presented, which relies on either selective or wafer-scale transfer bonding. Different adhesive coatings are used as bonding layers, which have to provide sufficient bonding strength during processing and act in addition as a sacrificial layer. For mechanical interconnection, the technologies of heat-activated bonding and ultrasonic welding are studied. The valves are actuated either by cold-rolled SMA foils of 20 µm thickness or sputtered thin films. In either case, the thermo-mechanical treatment is performed in free-standing form to avoid any kind of temperature incompatibilities, such as unwanted interdiffusion or thermal stress accumulation. For micromachining, the SMA material is fixed on a temporary substrate. Since critical steps of heat treatment and micromachining are performed separately, the presented technologies are compatible to temperature-sensitive polymers.