Capillarity-based Switchable Adhesion Device

Invention Summary
An instant-on/instant-off device inspired by the adhesion abilities of the leaf beetle was developed based on liquid surface tension forces.

Technology Overview
The device uses a large number of very small liquid bridges that can be instantly switched on or off, grabbing and releasing an object. The adhesive force of the liquid is proportional with the number of individual contacts, so scaling these contacts down allows more contacts and thereby a greater overall adhesive force, all within a compact design. Additionally, both grabbed and released configurations are stable equilibrium states that can be maintained without energy addition. Hence, only minimal energy is required for switching between states. A truly unique technology, the device will open new possibilities over an enormous range of fields from research and defense to medicine and consumer products.

An electro-osmosis pump was also developed that uses individually controlled oscillating liquid droplets to easily, carefully and quickly pick and place tiles in parallel. The invention uses the parallel-motion concept to increase efficiency, the self-assembly concept in that water droplets pick up tiles with no input other than a change in voltage, and the pick-and-place concept to individually choose tiles to move.

Potential Applications
- Load-bearing applications such as temporary wall or windshield mount
- "Spiderman" gloves
- Handling of silicon wafers or small tiles < 1 mm
- Pick-and-place manufacturing applications
- Force actuators with a large force multiplier
- Object propulsion via wettability gradients of droplets
- Microfluidic applications for precise fluid amounts

Advantages
- Reliable handling & transport for high-value materials
- High-speed, accurate, compact, easy to use
- Energy efficient with no solid moving parts
- Reduces cost by minimizing handling losses

Publications