Microgrippers for Assembling Microdevices

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There is a pressing need for the development of "smart" and wireless microscale devices for a variety of applications in medicine, defense and other fields. These devices typically require a variety of functionalities – for imaging, communication, logic/memory processing, sensing, and actuation. Because such multifunctional modules are often fabricated using varied processes and may come from a variety of different foundries, post-fabrication methods are needed to enable the assembly of tiny devices.

On the macroscale, robotic pick-and-place tools can be used to align and attach parts to specific devices on wafers. However, this serial procedure becomes increasingly difficult at submillimeter-length scales. An approach described in this paper enables wafer-scale assembly of tiny, diced silicon-based chips onto tetherless microstructured gripping devices. After release from the wafer, the grippers remain flat and close only when the modulus of the polymer trigger is reduced on exposure to specific environments that cause polymer dissolution, delamination, or softening. The energy required for concerted gripping motion is derived from the release of intrinsic strain patterned within metallic hinges and does not require any wires, tethers, or batteries. The environment-specific closing of grippers can be achieved in parallel, allowing large numbers of grippers to be actuated at once.

To demonstrate gripping as an alternative to gluing for the attachment of transponder tags, as well as compatibility with living creatures, a silicon-chip-integrated gripper was closed around the bristles of a fall webworm caterpillar. The gripper was dropped onto the caterpillar in its open conformation and actuated with a 10 microliter droplet of acetone. The gripper closed tightly around the small spiny bristles of the caterpillar, and the caterpillar continued crawling on the leaves and eating. These microgrippers can be utilized for a variety of security, defense, and medical applications.

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