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主催: 慶應義塾大学理工学部機械工学科
Department of Mechanical Engineering, Keio University

日 時(Date):
2019年6月3日(月)(June. 3, 2019 (Mon.)) 10:45～12:15

場 所(Venue):
厚生棟大会議室 (16th Building A 3F conference room)

講演題目(Title)

Structured surfaces with tunable adhesion and their application in small-scale manufacturing

講演者(Speaker)

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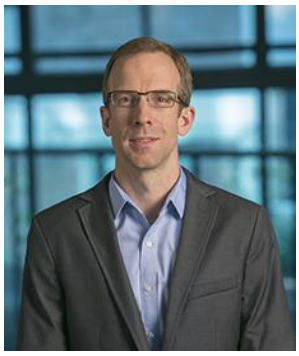

Abstract:

Small-scale pick-and-place assembly processes are gaining increased interest for manufacturing systems that require the local integration of high-performance materials and devices. Microtransfer printing is one example of a small-scale assembly process and it has been used to manufacture a broad range of heterogenous micro- and nano-systems, including flexible electronics, multi-material photovoltaic cells, micro-LED displays, and micromechanical systems. A key challenge in all small-scale pick and place processes is the need to "grip" and then release the component being transferred. Surfaces with tunable or switchable adhesion are a promising solution for controllably gripping small-scale objects. We have developed two new strategies for creating surfaces with tunable adhesion. Both approaches exploit structured composite surfaces, but the adhesion and hence tunability are achieved in different ways in the two approaches.

In the first approach, composite pillars comprised of a stiff core and a compliant elastomer shell are used to achieve enhanced adhesion under normal loading and the adhesion can be tuned through the application of shear. Finite element-based modeling was used to elucidate the underlying mechanics of these structures and design structures with specific adhesive characteristics. Experiments demonstrate dry (i.e., van der Waals mediated) adhesion strengths >1.5 MPa, significant tunability through shear loading, and the application of these composite structures as stamps for microtransfer printing of silicon nanomembranes. In the second approach, electrically tunable adhesion is realized through structured surfaces consisting of arrays of vertically aligned carbon nanotubes that are conformally coated with a thin dielectric layer. The structures were fabricated and characterized via controlled adhesion measurements and pick-and-place experiments. The surfaces offer significant adhesion tunability and the measured behavior is consistent with analytical models that have been developed.

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