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Octopus-Inspired Suction Cups with Embedded Sensors and Actuators

Background

Soft robots have the ability to bend, deform, configure, and adapt to their surroundings, making them an ideal choice for navigating unpredictable, unstructured, and confined environments. However, challenges remain with controlling high-dimensional appendages, and the development of versatile soft robots is still in progress.

Octopuses have soft bodies and arms, and can achieve a diverse array of locomotive modes including swimming, jetting, crawling, and bipedal walking. The sucker attachment mechanism that octopuses use allows for a variety of functions including sensing, exploring, and manipulating objects, anchoring the body during crawling, and navigating through narrow passages. Further study of octopus control architecture has the potential to inspire future soft robotics designs.

Invention Description

Researchers at Arizona State University have developed octopus-inspired soft suction cups for advanced packaging and soft robotics to handle brittle materials. The suction cups have embedded radial “muscles” for attachment made from a polymer incorporated with shape memory alloy for actuation, circular “muscles” for detachment made from the same material, and resistive/capacitive sensors for shape sensing. This technology allows for individual suction cup actuation and tactile feedback, which helps to increase manufacturing efficiency.

Potential Applications

- Advanced packaging for semiconductors
- Soft robotics handling of brittle materials (e.g., substrates)
- Locomotion & attachment in aquatic environments (e.g., maintenance)

Benefits and Advantages

- High-precision control – individual suction cup actuation and tactile feedback allows for safe and efficient handling of varying sizes and weights of material
- Can accommodate irregular shapes – 3D topography feature allows adaptation to various shapes
- Resilient – maintains a secure grip even in power loss, protecting against damage
- Contamination protection – minimizes the risk of contamination through residue-free contact
- Electrostatic discharge mitigation – protects sensitive semiconductor materials from potential damage

Related Publication: [New Insights on the Control and Function of Octopus Suckers.](#)