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Tattoo-Like Strain Gauges Based on Silicon Nano-Membranes
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This talk reports the in vivo measurement of tissue deformation through adhesive-free, conformable lamination of a tattoo-like elastic strain gauge consisted of piezoresistive silicon nano-membranes strategically integrated with tissue-like elastomeric substrates. The mechanical deformation in soft tissues cannot yet be directly quantified due to the lack of enabling tools. While stiff strain gauges for structural health monitoring have long existed, biological tissues are soft, curvilinear and highly deformable in contrast to civil or aerospace structures. An ultra-thin, ultra-soft, tattoo-like strain gauge that can conform to the convoluted surface of human body and stay attached during locomotion will be able to directly quantify tissue deformation without affecting the mechanical behavior of the tissue. While single crystalline silicon is known to have the highest gauge factor and best elastic response, it is intrinsically stiff and brittle. To achieve strain gauges with high compliance, high stretchability and reasonable sensitivity, single crystalline silicon nano-membranes will be transfer-printed onto polymeric support through carefully engineered stamps. The thickness and length of the Si strip will be chosen according to theoretical and numerical mechanics analysis which takes into account for the tradeoff between stretchability and sensitivity.

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