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## Scalable manufacturing processes with soft materials

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### ABSTRACT

The emerging field of soft robotics will benefit greatly from new scalable manufacturing techniques for responsive materials. Currently, most of soft robotic examples are fabricated one-at-a-time, using techniques borrowed from lithography and 3D printing to fabricate molds. This limits both the maximum and minimum size of robots that can be fabricated, and hinders batch production, which is critical to gain wider acceptance for soft robotic systems. We have identified electrical structures, including both resistance-based sensors and inter connects, as a critical starting point for developing more complex soft robotic structures. In this talk, we present our study on scalable manufacturing processes with soft materials, focusing on direct patterning of micro channels with laser ablation and layer-to-layer bonding of hyper elastic polymer substrates. The use of direct laser fabrication has three major advantages. First, it allows for rapid design iterations, because molds are not required. Second, it is scalable to larger substrates than mold-based approaches, because a laser-based system can pattern a continuous substrate. Third, a laser-based approach removes the challenges associated with incomplete material removal in through-layer structures that are encountered in mold-based approaches. Using this approach, we have fabricated strain gauges, layer-to-layer electrical interconnects, and comb capacitors, all by injecting liquid metal into closed microchannels embedded in polymer films.