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Abstract

Ablative Laser Structuring for Stretchable Multilayer and Multi-Material Electronics and Sensor Systems †

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Abstract: Conventional machining and shaping processes for polymers and elastomers such as injection molding exhibit significant disadvantages, as specific tools have to be manufactured, the method of machining is highly dependent on the material properties, and the cost of automation is usually high. Therefore, additive manufacturing processes (3D printing) have established themselves as an alternative. This eliminates the expensive production of tools and the production is individualized. However, the specific (additive) manufacturing process remains highly dependent on the properties of the material. These processes include selective laser sintering (SLS) for powdered thermoplastic polymers and metals, extrusion such as fused deposition modeling (FDM) for thermoplastic polymers in wire form, or optical curing such as digital light processing (DLP) for liquid resins. Especially for elastomer sensors or circuit boards (structure of several alternately constituted approx. 100 µm-thick elastomer films made with different types of liquid silicone rubber), there is no suitable additive manufacturing process that combines liquid, partly non-transparent source materials, multi-component printing, and very fine layer thicknesses. In order to enable a largely automated, computer-aided manufacturing process, we have developed the concept of ablative multilayer and multi-material laser-assisted manufacturing. Here, the layers (conductive and non-conductive elastomers, as well as metal layers for contacting) are first coated over the entire surface (e.g., spray, dip, or doctor blade coating, as well as galvanic coating) and then selectively removed with a CO_2 or fiber laser. These steps are repeated several times to achieve a multi-layer structured design. Is it not only possible to adjust and improve the work previously carried out manually, but also to introduce completely new concepts, such as fine through-plating between the layers to enable much more compact structures to be possible. As an exemplary application, we have used the process for manufacturing a thin and surface solderable pressure sensor and a stretchable circuit board.

Keywords: ablative laser structuring stretchable electronics; elastomer; sensor