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PROCEEDINGS

User-Interactive Printed Capacitive Smart Structure Manufacturing, Properties, and Applications

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ABSTRACT

Printing simple and smart structures that respond to external stimuli has attracted tremendous attention and research efforts [1]. However, the widespread and rapid adoption of smart structures in applications heavily relies on the development of advanced manufacturing technologies that build upon existing industrial capabilities, with essential modifications in design, equipment, process, and material etc., while having little effect on conventional manufacturing flow. In this talk, we will discuss capacitive smart structures that possess 2 dimensional (**2D**), **3D**, as well as **4D** features and functionalities, and are fabricated via conventional manufacturing methods. **(1) First of all**, the 2D lightweight and flexible interactive display, it offers tremendous benefit to simplify work task and improve human life was under intensive investigation for decades. Inorganic phosphor powder-based light emitting capacitor (LEC) lives with ambient manufacturing condition and simplest sandwich device feature received a lot of attention on exploring its potential in visualize mechanical, motion and thermal stimuli. Combined with microfluidic design concept, biomolecular interactive LEC (BIO-LEC) has been developed to facilitate the transduce of external liquid stimuli into light intensive signals [2]. Furthermore, a miniaturized biomolecular onsite interactive light emitting capacitor (BIOON-LEC) with advancing in microfluidic design and using disposable batteries will also be introduced [3]. **(2) Second**, the 3D structured functional Additive manufactured (AM) features, such as robotics and prosthetics, one of the promising steps to increase the functionality seems to be embedding printed sensors into the 3D structure during AM printing process. Clearly, most of the current development are done by hybrid approach that embeds silicon sensors into the printed features, conductor infusion approach that infuses conductive materials, and multi-material printing approach that combines conductive and non-conductive filaments. However, manufacturing difficulties and complexity are increased with inducing multiple approaches in the processes. Here, we introduce a laser assisted graphitization process into the layer-by-layer AM printing process [4]. Laser-induced graphene (LIG) sensor nodes are being in-situ fabricated via direct thermal and chemical transfer of the raw filament materials in the AM feature. By simply change the designed LIG patterns, embedded temperature, pressure, and approach sensors could been fabricated. This method will further reduce the sensor assembly requirements in the manufacturing flow. And the development of this technology could further strengthen the application of AM functional features with sensors in the complex structure, expanding customizable performance and opening unprecedented possibilities. **(3) Third**, 4D additive manufactured (4D AM) simple, lightweight, and smart shape memory structures (4D AM smart structures) that change shape over time, aiming to simplify complex mechatronics systems in space and aerospace deployable system, have garnered significate attention recently. Here, we will briefly introduce our current AM setups, discuss our current development in this field, as well as our research plans for the pipeline focusing on design library, materials, and process developments. Overall, enable by advanced manufacturing processes, systems and technologies, there is no doubt that the smart structure being developed will further enhance our industrial capabilities and applications.

KEYWORDS
User-interactive; capacitive smart structure; 4D AM smart structures

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