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Continuous 3D Printing of Architected Piezoelectric Sensors

Piezoelectric materials can convert mechanical energy to electricity or vice versa and have enabled diverse applications such as energy harvesting and self-powered sensing. A wide variety of inorganic ceramics and organic polymers have been considered as piezoelectric materials. However, neither the piezoelectric ceramics nor the piezoelectric polymers can simultaneously meet the demands from applications in flexible, wearable, or implantable electronics in terms of performance, mechanical flexibility, or ease-of-processibility. Incorporating piezoelectric nanoparticles into flexible host matrices has proven to be a satisfactory strategy in developing composites that possess both decent piezoelectric responses and tailorable, compliant mechanical performance.

Additive manufacturing, also known as three-dimensional (3D) printing, is thriving as an effective and robust method in fabricating architected piezoelectric structures. For example, current 3D printing methods being used include fused deposition modeling, inkjet printing, and projection micro-stereolithography (PμSL). Yet these commonly adopted printing techniques often face the inherent speed-accuracy trade-off, limiting their speed in manufacturing sophisticated parts containing micro/nanoscale features.

Researchers at Arizona State University (ASU) have developed a method for 3D printing microscale piezoelectric sensors in minutes. Specifically, ASU researchers formulated stabilized, photocurable resins comprising chemically functionalized piezoelectric nanoparticles from which microscale architected 3D piezoelectric structures can be printed continuously via micro continuous liquid interface production (μCLIP) at speeds of up to 60 μm/s. This is more than ten times faster than previously reported stereolithography-based works. Using this method, ASU researchers successfully produced lattice structures and tested the piezoelectric sensing performance and mechanical flexibility of those structures during several sensing applications, e.g., force sensing, motion recognition, and respiratory monitoring.

Related publication: Continuous Three-Dimensional Printing of Architected Piezoelectric Sensors in Minutes

Potential Applications:

- 3D printing method for producing piezoelectric sensors

Benefits and Advantages:

- Rapid, continuous printing of sophisticated, multi-scale 3D structures with stairstep-free surface finishes and homogenous properties
- 3D structures fabricated using ASU method have piezoelectric performance

comparable to state-of-the-art PμSL-based works and are fabricated at speeds that are at least one order of magnitude faster