Additive Manufacturing for Electronics


Additive manufacturing (AM) has made great strides in development over the last few decades. Through novel manufacturing technologies to innovative material systems, these technologies have enabled the production of new and exciting products. The success of AM on the commercial scale hinges on its adoption in the manufacturing of complex geometry assemblies. The packaging and manufacturing of thin and flexible electronics provide a proving ground for the combination of novel materials and cutting-edge AM hardware to produce parts capable of changing how we engage with electronics.

The work presented showcases the ongoing efforts of the Electronics and Materials Devices Division (EMDD) of the Applied Research Lab (ARL) at Penn State. Highlights of the project include passive radio frequency (RF) antennas and resonators, carbon-based conductor inks, biosensors for bacteria detection, and highly conductive particle-less silver inks.

As part of the continuing demand for lighter weight, nontoxic, recyclable conductors, graphene-based conductive inks are being explored. Current efforts are focused on improving the interparticle bridging between flakes of graphene with the use of materials processing and incorporating various metallic and organic additives. With extrusion AM, the use of particles becomes problematic as the shape, texture, and size of the particles affect the rheology during the printing process. The development of inks with suspensions of metallic conductors trapped in salts leads to a “particle less” ink with a more consistent flow. The AM process enables rapid prototyping of novel devices with silver nanoparticle ink. Such novel devices include localized heating elements for unique research applications, multi-material biosensors for the detection of electroactive byproducts from specific bacteria, and specially tuned ring resonators for 5G/6G communications development.