

# Development of Test Methods and Standards to Assess Reliability of FHE Components and Systems



In this proposal, Georgia Tech, Binghamton University, and DuPont plan to develop various mechanical test methods that are intended to assess the performance and reliability of flexible hybrid electronics (FHE). In particular, this proposal aims to develop monotonic stretch tests, bending tests of different radii, and twisting tests of different angles to assess the mechanical fracture limits of these various tests as well as fatigue tests with several stress/strain amplitudes, with and without pre-loads, to develop fatigue failure curves. Peel tests, shear tests, modified double-cantilever beam, modified four-point bend, and fixtureless tests will be developed to determine the adhesion strength and interfacial fracture energy of printed components on flexible substrates as well as that of chip-to-substrate interconnects. In addition to mechanical failure loads and failure cycles, this work will also assess the evolution of electrical characteristics under DC as well as over a wide range of frequency from MHz to GHz with the continued application of mechanical loads. Also, some of the tests will be conducted at different temperatures ranging from -50 to 250 °C to assess the effect of temperature on the mechanical and electrical behavior.

In addition to developing the test methods, this proposal will also develop numerical models that will capture time-, temperature-, and direction-dependent material properties to mimic the mechanical tests and to understand and interpret the stress/strain distribution during the tests. Such numerical models will also be extended to establish correlations between accelerated tests and application-specific field-use conditions.

As the test methods mature, the team will regularly interact with standards organizations as well as various collaborating companies to make sure that the developed methods and procedures are acceptable, easy to use, adaptable, and relevant to the FHE ecosystem. The test methods will be made available to NextFlex Hub and other members, as appropriate, so that the test methods can be practiced across a broad spectrum of FHE ecosystem. Also, this project plans to develop courses aimed at workforce development so that personnel can be trained to perform mechanical tests to assess reliability and performance of FHE materials, components, assemblies, and systems.

