Test Methods for Electrical and Mechanical Durability of Flexible/Rigid Interfaces in Multi-Axial Fatigue and Dynamic Loadings

Alireza V. Amirkhizi (PI), University of Massachusetts, Lowell

Abstract: This effort seeks to establish customized test methods and necessary infrastructure for characterization of the mechanical strength and electrical integrity of selected simple and complex flexible hybrid electronic (FHE) devices. Of particular interest are the effects of large deformations, multi-axial stress states, impact loads, stiffness mismatch, electrical bias, and temperature on material and interface durability. The constitutive and failure data collected as the samples undergo static, dynamic, and fatigue loadings will be used to calibrate existing or new models and introduced into computational software suites. This will in turn enable the manufacturing partners to reduce their non-recurring engineering (NRE) costs in design evolutions. The combination of large deformation of the flexible components and the localized stress concentration creates a complex micromechanical problem. Hence, integration of advanced modeling is essential to both test design and model calibration, while involvement of test equipment manufacturers will influence the next generation of commercial test equipment. Ultimately, the protocols and infrastructure established in this effort will be available for use by the larger FHE manufacturing, research, and development community, and the knowledge base created will be of great value for analysis and adoption by standardization organizations.

Objectives: The objectives of this proposal are:

1. Devise testing protocols for application relevant environments and parameters (rate, stress tri-axiality, …) for **3 representative examples** identified in this proposal
2. Measure mechanical and electrical integrity (strength, resistance curves, …) of representative FHE components, composites, and complex device architectures to:
   i. Verify test method applicability
   ii. Calibrate material and failure models relevant to FHE and integrate them in computational software suites for design, analysis, and validation
3. Create unified and centralized laboratory facilities for characterization of mechanical strength and electrical robustness of FHE components and devices including:
   i. Independent and multi-axial control of loads (e.g. tension and shear) and electrical bias
   ii. Temperature and strain rate control
   iii. Large deformation mechanics
4. Disseminate the experimental methods, modeling approaches, and material properties through a proposed end of program workshop, and final progress report