Abstract
Special thermal interface materials are required for connecting devices that operate at high temperatures up to 300°C. Because devices used in power electronics, such as GaN, SiC, and other wide bandgap semiconductors, can reach very high temperatures (beyond 250°C), a high melting point, and high thermal & electrical conductivity are required for the thermal interface material. Traditional solder materials for packaging cannot be used for these applications as they do not meet these requirements. Sintered nano-silver is a good candidate on account of its high thermal and electrical conductivity and very high melting point. The high temperature operating conditions of these devices lead to very high thermomechanical stresses that can adversely affect performance and also lead to failure. A number of these devices are mission critical and, therefore, there is a need for very high reliability. Thus, computational and nondestructive techniques and design methodology are needed to determine, characterize, and design the packages. Actual thermal cycling tests can be very expensive and time consuming. It is difficult to build test vehicles in the lab that are very close to the production level quality and therefore making comparisons or making predictions becomes a very difficult exercise. Virtual testing using a Finite Element Analysis (FEA) technique can serve as a good alternative. In this project, finite element analysis is carried out to help achieve this objective. A baseline linear FEA is performed to determine the nature and magnitude of stresses and strains that occur during the sintering step. A nonlinear coupled thermal and mechanical analysis is conducted for the sintering step to study the behavior more accurately and in greater detail. Damage and fatigue analysis are carried out for multiple thermal cycling conditions. The results are compared with the actual results from a prior study. A process flow chart outlining the FEA modeling process is developed as a template for the future work. A Coffin-Manson type relationship is developed to help determine the accelerated aging conditions and predict life for different service conditions.