SAND2016-0730C

Quantifying Uncertainty in Material Model Selection in a Hermetic Connector

Brenton Elisberg

Glass-to-metal seal (GTMS) connectors are used to feed electrical conductors through walls of hermetically sealed electronic packages. A typical GTMS connector consists of an outer metal shell that houses a glass element formed to surround an electrical conductor that passes through the metal shell. When the connector is brought to a sufficiently high temperature, typically hundreds of degrees Celsius above the glass transition temperature (Tg), the glass flows to create a seal before being cooled back to room temperature as part of the manufacturing process. Different types of seals can be created depending on the material set, but when the coefficient of thermal expansion (CTE) of the metal shell is greater than the CTE of the glass and conductor a "compression seal" is created as the connector is cooled. High compression from the metal shell causes plastic deformation in the shell and conductor that leads to a nonlinear evolution of tensile stress in the glass that can muddle engineering intuition during the GTMS design process. Because the cost of producing a hermetic GTMS connector increases with design and material selection complexity, finite element analysis (FEA) tools are increasingly necessary during the design process to drive down cost and improve product yield.

This presentation will explore the complexities of simulating the manufacturing procedure of a hermetic GTMS connector using an amorphous Schott 8061 type glass, Alloy 52 conductors, and a stainless steel housing to produce a compression seal. Traditionally, GTMS simulations have been performed using modest constitutive models and an assumed stress free temperature of the connector close to the Tg of the glass. This has been used to predict qualitative trends in design alterations while neglecting thermal histories that can contribute to significant tensile stress in the hermetic seal. To increase quantitative fidelity, recently gathered material properties have been used to calibrate a viscoplastic constitutive model for the stainless steel and viscoelastic constitutive model for the amorphous glass. These models have been used to predict changes in the stress state of the hermetic seal due to different manufacturing histories and long-term storage of a connector. Various FEA predictions will be examined using combinations of elastic, viscoplastic, and viscoelastic constitutive models to determine the level of complexity needed for qualitative and quantitative accuracy.

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.