Center for Advanced Vehicle Electronics (CAVE3)

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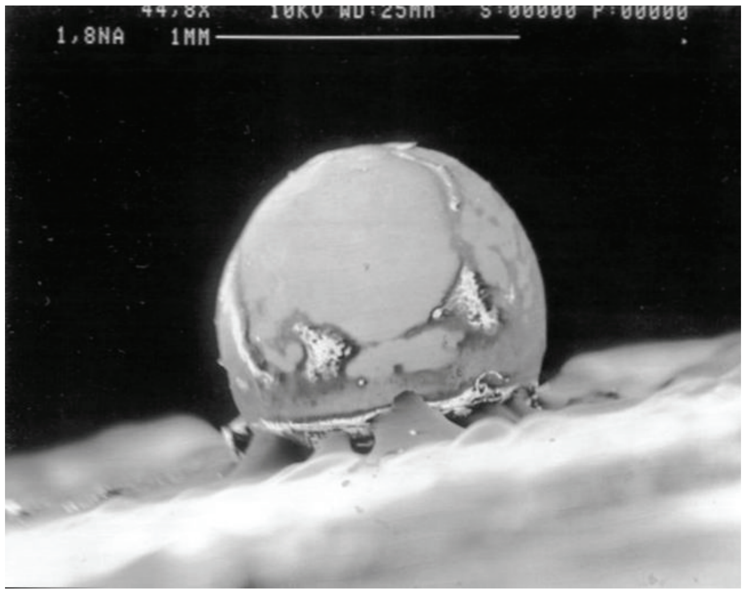
Center website: http://cave.auburn.edu/

New Experimental Techniques to Study Solder Materials and Processes



A molten solder ball.

Work in CAVE3 has led to the development of several new innovative experimental techniques to study solder alloys. A unique scanning electron microscope has been developed that allows for real-time and in-situ studies of the melting, wetting, and spreading of solder alloys and pastes. The system allows for microscopic observation of the advancing molten solder with simultaneous analysis of alloy-substrate chemical reactions during wetting. It is highly unusual to undertake studies of liquids in expensive and high-performance vacuum systems due to potentially high vapor pressures and flux outgassing. Results from the use of this novel facility have especially benefited CAVE3 industrial sponsors who use solder materials and technology. In addition to the ability to study molten solders, CAVE is the first organization to develop a scanning electron microscope to measure strains in materials during repetitive temperature cycling processes such as those common in under-the-hood electronics. A third unique apparatus in CAVE is a custom-made surface analysis system that enables in-situ studies of surface segregation during melting and wetting processes.

Economic Impact: The ability to study fundamental properties of electronic materials in-situ has reduced the development costs associated with new electronic platforms. In absence of these new experimental methods, significant system level testing would have to be undertaken for validation of the material performance in electronic manufacturing process. The reduced material development time is expected to result in faster time to market.

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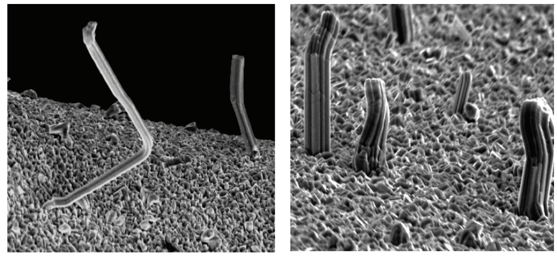
Lead-Free Solder Alloys for Harsh Environment Applications



Tin whiskers that can lead to short circuits in lead free electronics.

Determine of the viable lead-free alternatives is necessary for long-life electronic systems such as defense and industrial electronic systems. Researchers at the Center for Advanced Vehicle and Extreme Environment Electronics (CAVE3) have developed a number of important methodologies related to electronics assembly with lead-free solder alloys. This research has international significance due to the ban on the element lead (Pb) enacted in the EU and Japan during 2006. The problem with lead-free electronics is not that there is a dearth of alloys, but that there have been a lot of alternative alloys proposed – most of which are not well understood in terms of their performance and reliability in extreme environment applications. Harsh environment systems require long extended period of operation under extreme environments. CAVE has become one of the first organizations to intensively study the materials science, mechanical behavior and solder joint reliability of leading candidates for lead-free solder alloys formulated from tin, silver and copper.

An innovative approach for lead-free solder prognostics has been established that allows users to estimate the remaining useful life of solder joints. Researchers at CAVE are leading efforts to characterize aging effects in lead free solder alloys that result in unexpected degradation of lead free solder joints in extreme environments. This work has helped CAVE3's industrial partners stay ahead of their competition in their respective technological areas. The research has demonstrated not only what will work, but more importantly, what will not work. By not wasting time on dead-end research, CAVE3 has helped member companies narrow the options to cost-effective and reliable alternative solders that can be used in commercial, industrial, and military electronics for extended years of service.

Economic Impact: Automotive systems often need 10-years, 100K miles. Defense systems require 15-20 year operation with extended periods of storage. Transition to lead-free electronics will result in long-term obsolescence of leaded electronic components. Achieving longer-life electronic systems relies on lead-free alternatives and mixed technology assemblies. Techniques developed at CAVE3 should reduce sustainment costs of the systems to the benefit of industry and the nation.