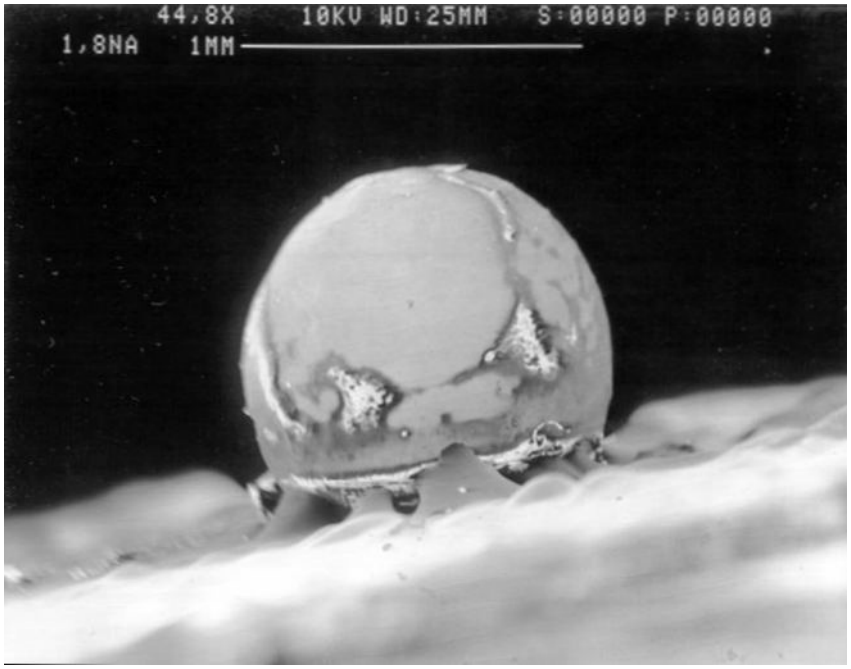
Center for Advanced Vehicle Electronics (CAVE)

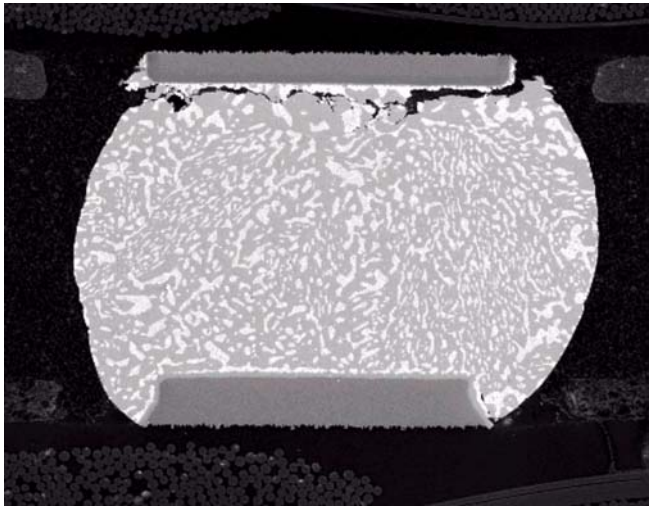
Auburn University
Dr. Jeff Suhling
Phone: 334-844-3332
E-mail: jsuhling@eng.auburn.edu

Improved Electronic Circuitry for Terrestrial and Space Vehicles



The Center for Advanced Vehicle Electronics (CAVE) has a number of industrial partners who design, develop, and manufacture state-of-the-art electronic circuitry for terrestrial and space vehicles. The electronics must operate reliably for long periods of time in hostile environments including high temperatures, low temperatures and high radiation fields. The center's work in materials physics and process breakthroughs based on long-term reliability studies of solder joints have identified a number of key factors which have impaired progress in circuit longevity. Studies to identify and measure the growth kinetics of brittle inter-metallic compounds that form in solder joints led to significant process improvements in flip-chip and ball grid array circuitry for Daimler-Chrysler Corporation. The processes have proven capable of stopping crack propagation in solder joints by controlling several critical process variables during soldering operations. Theoretical and experimental studies of the heat distribution on a circuit board using miniature thermocouples have led to identification of heat-susceptible locations on the board that impact circuit reliability. This has been especially useful for NASA, which has an abundance of circuitry located near hot rocket engines. For more information, contact Jeff Suhling, Auburn University, 334-844-3332; e-mail: jsuhling@eng.auburn.edu. *Above*: A molten solder ball.

New Experimental Techniques to Study Solder Materials and Processes



Work in the Center for Advanced Vehicle Electronics has led to the development of several new, innovative experimental techniques to study solder alloys. 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.The novel techniques have especially benefited Cookson Electronics and Loctite, two CAVE industrial sponsors who specialize in solder materials and technology. No comparable instrumentation exists elsewhere. This is the first scanning electron microscope that allows for real-time, in-situ melting, wetting, and spreading of Pb-free solder alloys and pastes. The system allows for microscopic observation of the advancing wetting and simultaneous analysis of alloy-substrate chemical reactions during wetting. CAVE's is the first laboratory to develop a scanning electron microscope to measure strains in materials during repetitive temperature cycling processes such as are common in vehicular-related under hood applications. 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. For more information, contact Jeff Suhling, Auburn University, 334-844-3332; e-mail: jsuhling@eng.auburn.edu. *Above*: Failed solder ball.

State-of-the-Art Electronics Assembly Operations and Pb-Free Solder Alloys

The Center for Advanced Vehicle Electronics has developed a number of applied and fundamental methodologies that directly impact the financial bottom line of several member companies. CAVE has become one of the first laboratories to study the materials science of leading candidate Pb-free solder alloys, particularly during formation of the metallurgical bond. Work on state-of-the-art electronics assembly operations and Pb-free solder alloys has helped industrial partners stay ahead of the pack in their respective technological areas. For example, Cookson Electronics and Loctite Inc., are leading manufacturers of electronic solder. This research has world-wide significance due to the expected ban on the element lead (Pb) by the year 2005. This ban will eventually impact every circuit board on planet Earth and has enormous financial implications. The research has demonstrated not only what will work but, more importantly, what will not work. By not wasting a lot of time on dead-end research, CAVE has helped Cookson narrow the options to cost-effective and reliable alternative solders that can be used in commercial, industrial, and military electronics. For more information, contact Jeff Suhling, Auburn University, 334-844-3332; e-mail: jsuhling@eng.auburn.edu.