

Tensile Testing of Leaded and Lead-Free Solders Using Sub-Sized Specimens

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Abstract

The electronics industry activities involved in the replacement of lead-tin eutectic solders with lead-free solders creates a need for critical data on the new lead-free solder compositions for design and reliability models. In addition, the mechanical reliability of solder joints is of great importance to prevent electronic failures.

A project, aimed to extract the differences between mechanical properties of lead-free solders and leaded solders has been initiated at the Materials Reliability Div., at the National Institute of Standards and Technology in Boulder, Colorado. Other collaborators are the Metallurgy Division at the Colorado School of Mines and the National Electronics Manufacturing Initiative (NEMI).

The major stages in the development of tensile-testing solder samples capability are illustrated. Solder miniature (cross section that is 250 μm by 200 μm and gage length of 500 μm) samples used are of the solder-ball sizes (used in flip-chip packages).

The procedures for soldering and specimens' preparation, as well as mechanical testing and data acquisition and analysis is shown too. A hydraulic tensile machine was outfitted with a control system to apply strain rates of $1 \times 10^{-5} \text{ s}^{-1}$ to the specimens. Video camera (having magnification capability of up to X750) is used as an "optical extensometer", e.g., capture images of the specimen's gage during the test and use image correlation techniques to measure the strain across the gage section.

Studies are being conducted on the effects of phase sizes, micro-structure, mechanical properties and the possible effects of strain rates.

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