Foil-Based Transient Liquid Phase Bonding Systems

COOLING TECHNOLOGIES RESEARCH CENTER

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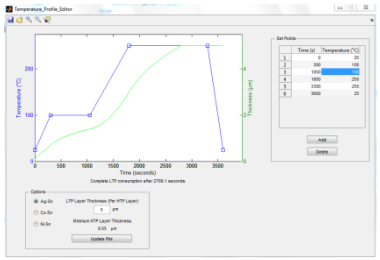
Objective

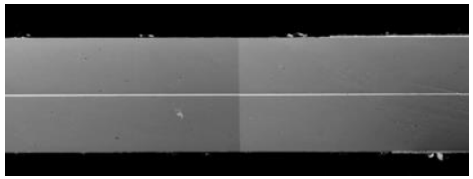
Develop modeling tools and kinetic models for transient liquid phase bonding (TLPB) for designing stable, high temperature structures for improved thermal conductivity and long term performance as thermal interface materials and die-attach applications .

TLPB appears at first glance to be a simple process: a low melting temperature liquid phase usually Sn-based, wets and reacts with two substrates to form a solid intermetallic (IMC) with no remaining liquid. The resulting IMC structure has a much higher thermal conductivity and stability than TIM greases, and melts at a higher temperature than the original low temperature phase, allowing for its use in higher temperature applications. However, the IMC phases that can form and the ability of the last liquid to be removed depend on alloy and substrate composition and processing conditions, with pressure sometimes needed to force the two surfaces into contact The resulting joint geometries and microstructures determine the thermal and mechanical properties of the joints .



1D calculator available to predict processing conditions required for different alloys, substrates, and Availability of the TLPB modeling tools may be extended to other applications, including TSV micropillars and die attach.

TLPB: Formation of thin bond lines for model experiments



Uniform, dense bondlines fabricated with thicknesses in the range of 3-10 µm are needed for heat-rail attach in power electronics.

Approach

- Create and disseminate calculator for predicting processing conditions needed for Sn-Ag, Sn-Cu, Sn-Ni TLPB systems.
- Develop improved 2D modelling capabilities using phase field modeling and experiments to predict microstructures for input into mechanical and reliability models.
- Develop optimized composition, processing, and geometry guidelines for three binary systems and at least one ternary TLPB system.

Impact

Developing modeling tools to predict such geometries and microstructures will help materials and process designers tailor structures for specific applications. with the aim of improving the processability, bond quality, phase stability, and thermal conductivity of TLPB systems. The TLPB modeling tools may be extended to other applications, including TSV micropillars and die attach.

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