Reliability Modeling of M CMs

This paper will describe the reliability modeling performed under the RELTECH program, and will present lessons learned which can be used by other investigators in the advanced packaging fields.

covered with dielectric. This process is repeated for as many layers as necessary for routing the inter-chip circuitry, with openings, or vias providing inter-layer electrical connections. Typical dielectric materials are polyimides and SiO2, and the conductors are typically aluminum, copper, or gold. Figure 1 shows a sketch of typical vias connecting metal layers within an MCM-D.

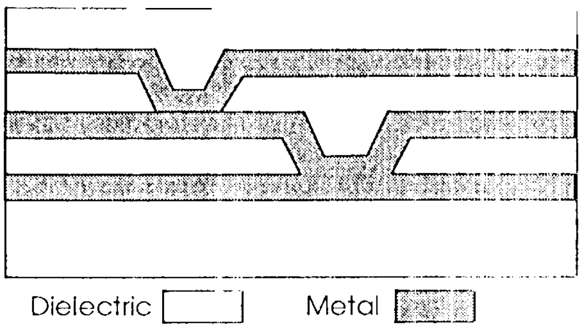


Figure 1 - Typical Vias in an MCM-D Interconnect.

The RELTECH program was created by ARPA, the military services, and NASA to assess key MCM technologies, identify the reliability issues inherent with each, and develop effective tests, inspections,

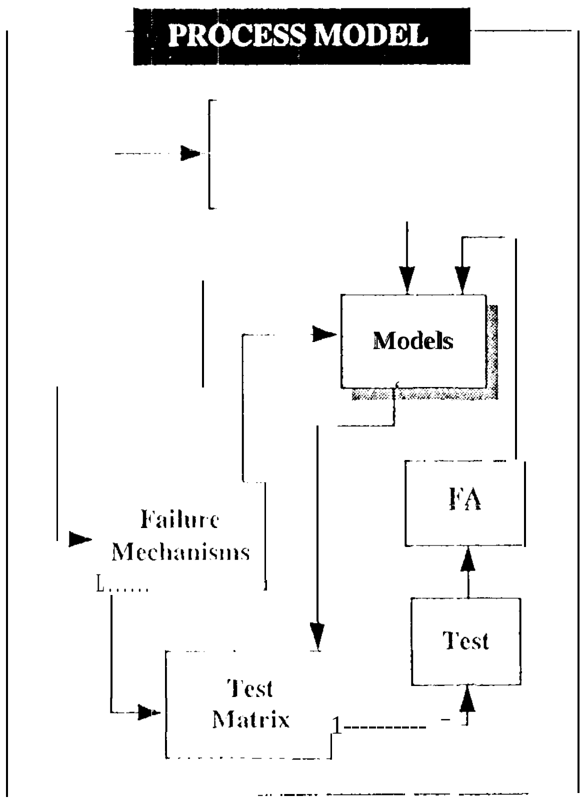


Figure 2 - Process Model For RELTECH MCM Technology Assessment.

The technologies examined to date have been variations of the MCM-D concept. Copper/polyimide, and aluminum/SiO2 high density interconnects.

As described above, a part of the RELTECH program has concentrated on the reliability modeling of these technologies. Through the use of finite element models, the modeling team has endeavored to identify potential failure mechanisms within the MCM interconnect structures due to thermally induced stresses, both static and cyclical. The modeling effort has yielded valuable lessons learned in terms of the approach to a new technology evaluation, Some of the modeling activities which can benefit a new technology include the ability to perform design trade-offs prior to building prototype hardware, definition of accelerated test stresses, and facilitation of the failure analysis through identification of potential failure sites.

Reliability **Modeling**

The reliability modeling of the MCMs has typically started with a thermal model of the entire MCM package. This model is referred to as a 'global' model, and is used to predict the thermal performance of the module. The temperature rise through the stack-up of materials from the Lop of the chip to the bottom of the package is evaluated, along with the temperature distribution within model with the top cover of the module partially removed.

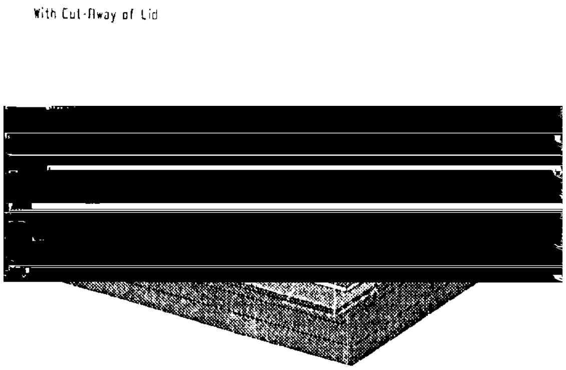
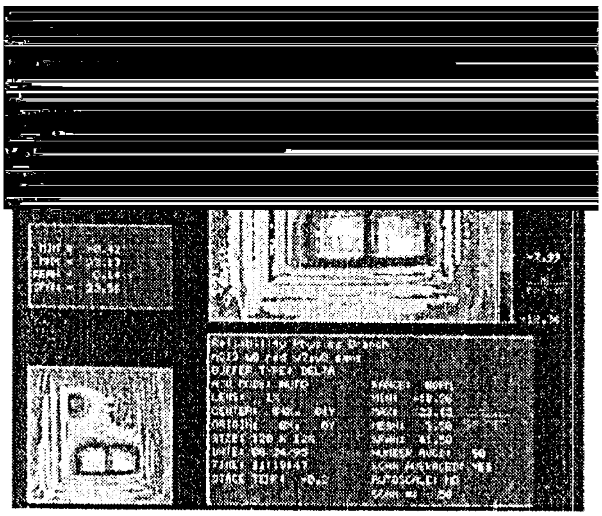
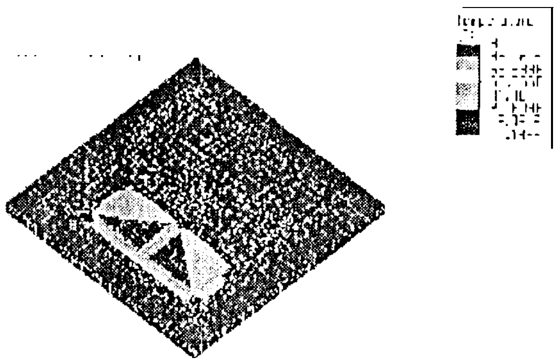


Figure 3 - View of Global Model With **Cover Cut Away**

IR thermal images created by Rome Labs (see





Material Properties

In addition to accurate geometric data, the analytical models rely heavily on the quality of the material properties used. In recent studies, many days have been spent searching for material properties relevant to the problem being analyzed. It is important to remember that bulk properties are often substantially different from thin film properties for the same material. This is particularly true for elasto-plastic properties for metals, used in predicting the stress and strain resulting from thermal effects in a module.

Additionally, care must be taken in modeling polymeric materials. These often have temperature dependent CTEs, as well as viscoelastic behavior conduction, the analytical tools must be able to properly simulate these as well. When modeling the effects of large temperature excursions on a module, a package capable of properly handling material non-linearity is required. The analytical solution must be able 10 accommodate elasto-plastic constitutive models for the material propel-lies, and if creep effects (such as seen in polymers) are to be modeled, the tool must be able to

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