NCMS Update

Ron Evans

The National Institute of Standards and Technology (NIST)/National Center for Manufacturing Sciences (NCMS) PWB Interconnect Systems Program is in the third year of its five-year duration. This year IBM's Endicott facility joined the existing participants, which include AlliedSignal, AT&T, NCMS, NIST, Sandia National Laboratories, Texas Instruments and United Technologies/Hamilton Standard. IBM is currently working with the other participants on four research teams-surface finishes, imaging, materials, and product development.

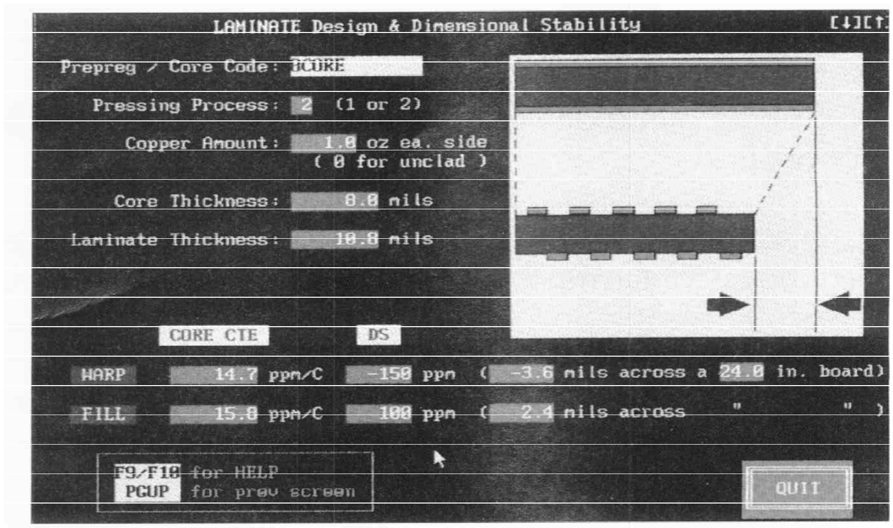

Figure 1. Software package developed to facilitate prepreg and laminate design

Surface Finishes Team

This group has been focused on developing a simple nettability test method to determine PCB soldurability. The goal is to formulate a method that will predict assembly defects with a higher degree of confidence.

The team compiled correlation data using a metal nettability test vehicle (MWTV). The PCB allows for nettability testing of coupons and serves as a tool for evaluating surface finishes for applicability to assembly.

The group has pared the test method candidates down to three choices: a solder float test, a drag test, and a patent-pending test involving the capillary flow action of solder. The first two tests have provided the most accurate prediction of assembly defects. The latter method may serve as an easy, quantitative method for testing bare copper surfaces and organic soldera-bility preservative (OSP)-treated copper surfaces.

Nondestructive methods of stressing the protective surface finish, which include accelerated temperature, humidity, storage, and handling conditions, are being used on metallurgical finishes and on OSP-treated copper surfaces.

This work is trending toward the use of simulated assembly test vehicles. A soldcrability test vehicle (STV) has been designed to build on the preliminary findings of the MWTV. Using this vehicle, solderability and reliability data can be gathered and correlated to the fabrication phase. The test vehicle has also been adopted by the NCMS' Alternatives to Lead-Based Solders project.

Another focal point for the Surface Finishes Team is removing lead from the board finish. A lot of the effort has been centered on evaluating OSPs over bare copper. Azoles and modified azoles have been targeted to accomplish this task.

In addition to meeting the process and performance demands of the typical SMT process, storage, temperature, and humidity environments, an OSP material must have sufficient thermal stability to protect copper solderability during the thermal processes entailed in mixed-technology assembly. These include baking the board to remove moisture, infrared/convection topside SMT reflow, and infrared/convection bottomside adhesive cure. The OSPs must also be thermally and/or chemically "destable" enough so they can be de-absorbed or reduced during wave soldering with non-aggressive no-clean low-solids fluxes. AT&T has offered its patented OSP Imidazole on a commercial basis outside the company.

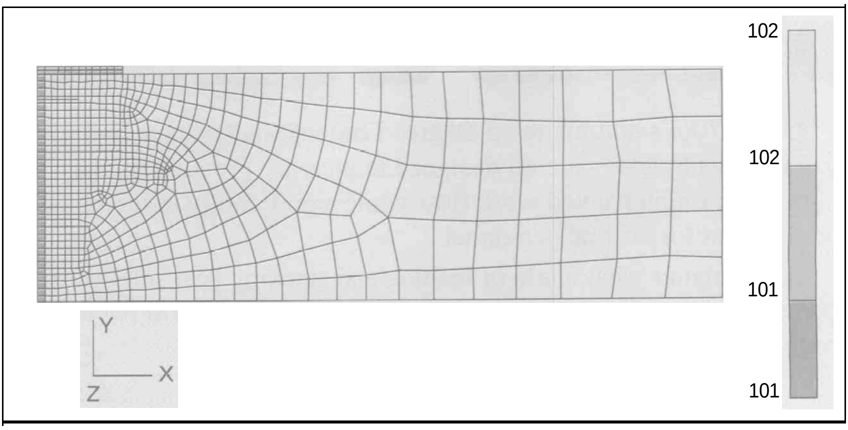

Figure 2. An axisymmetric FEM of a PTH.

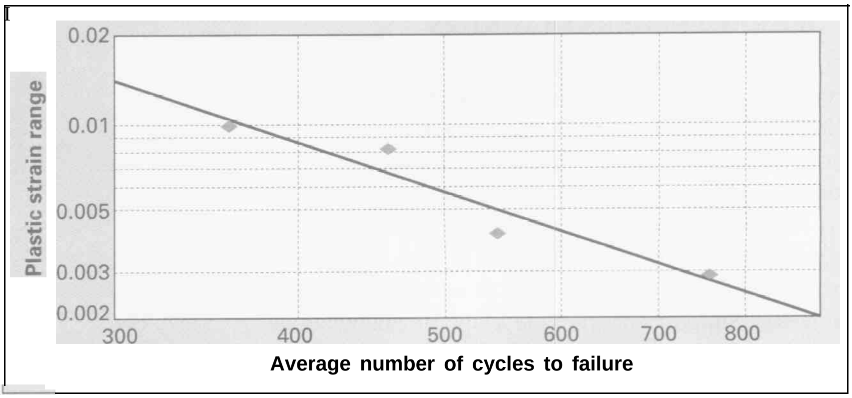

Figure 3. FEM and test correlations for thermal fatigue life of PTHs.

Imaging Team

This team's goal has been to form high-yield 6-mil-pitch conductor patterns. Test hardware and data analysis software have been developed to evaluate process capability by measuring defects (shorts and opens), density, and conductor uniformity.

Specially designed test patterns are used as vehicles for characterizing equipment, materials, and process steps. Information on defect density, predicted real product yield, and variation in conductor cross-sectional dimensions is generated.

Data from these tests indicates typical first-pass innerlayer panel yield for 6-mil-pitch designs is at less than 50%. The NCMS team's target is to increase this figure to exceed 90%.

Recent findings of the Imaging Team indicate that yield improvements as high as 11% were realized when processing the 3/3-mil test pattern through plasma etch for photoresist residue removal.

Additional findings have been issued on projection printing for resist exposure. Goals include eliminating deficiencies in conventional printing; the need to use hard contact for fine lines; and problems in storing, transporting, and handling full-size polyester-based phototools. The team has developed a prototype unit based on magnified-image projection printing (MIPP), which uses a reduced-size glass mask and a resist. It is not necessary to contact the critical mask surfaces, and the system is designed to expose standard UV-sensitive resist. Despite a few remaining problems, test results have been positive.

Materials Team

The first group in this arena, the Revolutionary Team, uses a leapfrog technology that maximizes the probability of exceeding the group's defined customer requirements in a cost-effective manner. Inroads have been made with high-temperature polyamides, low-modulus resins, self-reinforced films, low-CTE resins, and silicate fillers. New materials have been synthesized and studied at United Technologies' Research Center and at Sandia.

The second group, the Technology Assessment Team, has been assigned the mission of implementing an existing high-performance material that can exceed the ability of existing FR-4 to cost-effectively meet the defined customers' requirements. A report prepared by the team incorporates a database of leading-edge, commercially available materials whose processing capabilities and materials properties are detailed therein.

The objective of the third group, the Evolutionary Team, is to develop a product that uses a new combination of available technology/materials that meets or exceeds customer requirements in a cost-effective manner. The group has concluded that the primary impact of moisture in PCB composites lies at the resin-fiber interface and is heavily dependent on the nature of the coupling agents and resulting siloxane materials. Future areas of research, including the development of a no-bake laminate, have been identified.

A software package has also been developed to facilitate prepreg and laminate design (Figure 1).

Product Development Team

Focusing on factors that drive the need for advanced PCB technology, this group is looking into alternative structures and processes. The group is currently working on a model that will enable its members to cost out these alternative fabrication techniques while comparing them to conventional processes.

An advanced interactive software interface of finite-element modeling (FEM) code has been unveiled. The program yields a hefty reduction in model development time for thermal fatigue analysis of PTHs (Figures 2 and 3). Although the properties of all potential and existing laminates could not be provided, consultation on the properties of laminates with different systems may be obtained from the NCMS Product Team. **FAB**

Ron Evans is acting director, Electronics Manufacturing, with NCMS, Ann Arbor, Ml.