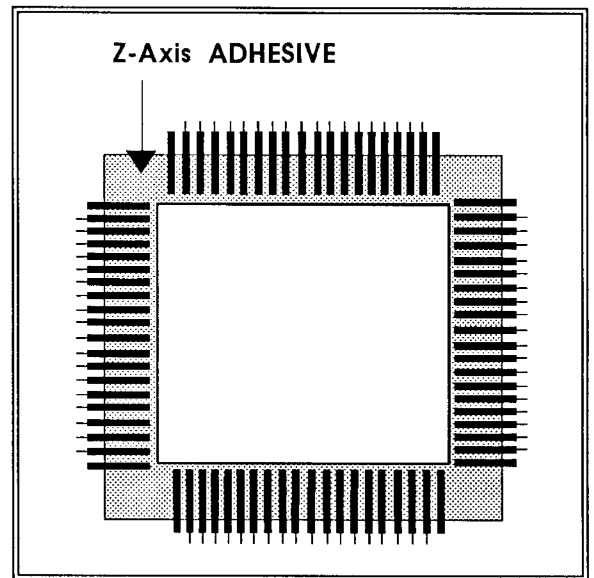
Development of Z-Axis Adhesives for SMT Assembly

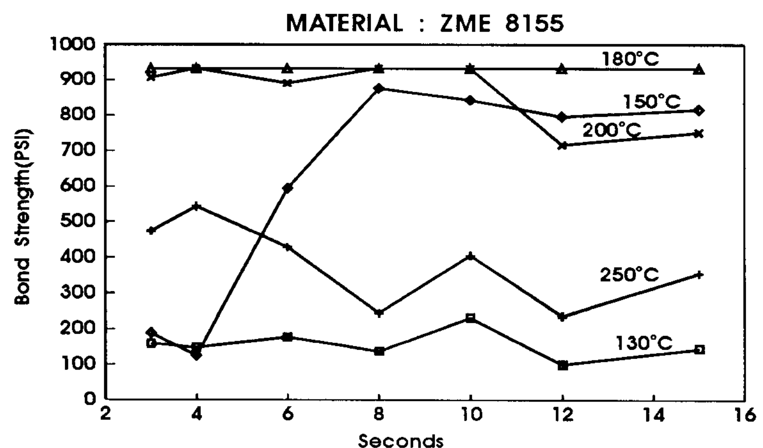
The surface mount industry has proven success of current solder processes at greater than 25 mil pitch through several years of experience. New developments in component technology have created a need to be able to mount a device which is beyond the capabilities of the current processes and materials. In an attempt to maximize the product benefits of the Z-Axis material, it is necessary to concentrate on those areas which cannot be manufactured using the current process. Using the Z-Axis as a direct replacement for the well established and proven process is somewhat redundant use of engineering efforts and does not highlight the product's advantages.

It is our recommendation that further development using the Z-Axis material should concentrate on those boards or components which benefit most from the new technology; i.e. 25 mil pitch or less. All processes have limitations with respect to pitch. More research must be done to clearly define the pitch limitations of the Z-Axis material (first generation), and what are the expected trends for component pitch configurations in the future (second generation). Through this research, material improvement needs can be established, as well as forecasting future process development modifications which will accompany the advancement in component technology.

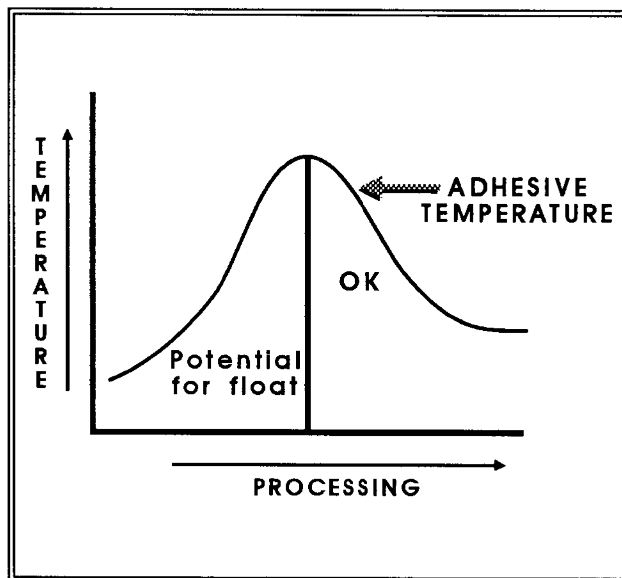


With the assistance of more sophisticated testing equiptment, research will enable process optimization with characteristics such as Bond Strength & Conductivity vs. Temperature & Time. By clearly defining the material characteristics, process and material modifications will be more focused and accurate, allowing for faster technology transfer. Within the capabilities of A.I. Technology laboratory, we have established preliminary results to indicate that 180°C for less than 3 seconds will optimize bond strength with regards to processing speed, however results at shorter time intervals has to be determined.

The manufacturing process using Z-Axis materials is further complicated by the need for force or pressure at the bond pad interface during a portion of the cure cycle. It is the integration of adequate temperature, controlled pressure, in a relatively short time, which will allow the material to be produced effectively in surface mount applications. There are several ways in which these technologies are currently used, however no apparent method exists in a high volume atmosphere. In the most generic and uncomplicated terminology the optimum machine would be an "automated high volume pick and place rework station - in reverse." It is essential to provide heat and pressure with the placement accuracy of an optical rework station, however for a high volume process, this machine must also work with the speed close to that of a pick and place SMT machine.



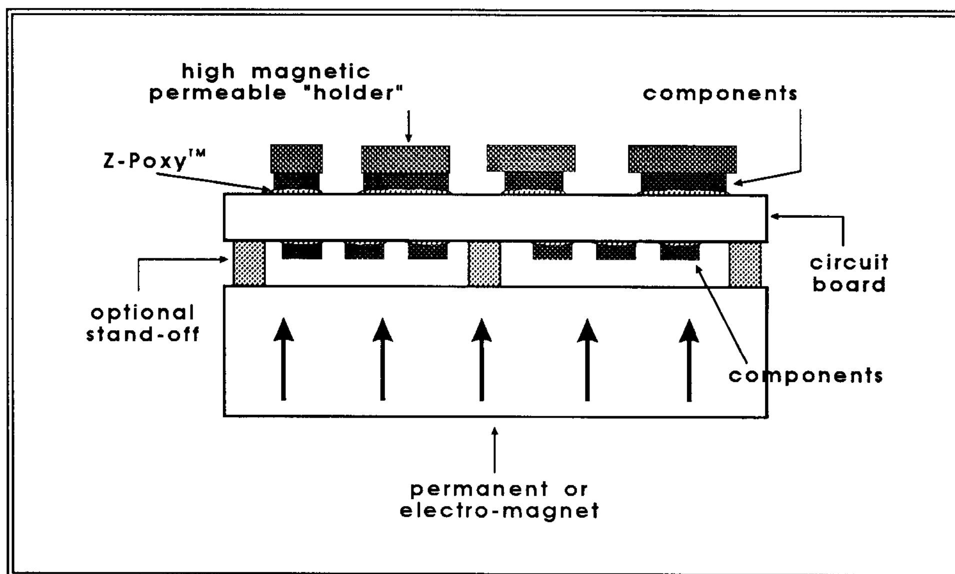
There are several different methods to transfer heat to the component in rework machines on the market today. Focused Infared, hot bar, hot gas, hot air, laser, are some of the ways that systems integrators currently employ heat to the leads. Logically, each method has its limitations and advantages, documentation of the potential for each method is necessary. More development needs to be conducted to determine which method is the most efficient to make the Z-Axis system production worthy in a high volume line.



Another method to increase processing speed is to preheat the Z-poxy on the board as well as the components, to reduce cure time when the leads are integrated to the epoxy system. This can be done at different stages, and with different methods, however more development needs to be done to establish the best heating profile, what adaptation of current machines is possible and necessary, and what are the ultimate capabilities. As lead pitch reduces, the capability of the placement machines with regards to x-y, and theta orientation must also be established and analyzed for maximum yield efficiency.

A.I. has also developed another concept to apply heat and pressure that warrants detailed investigation. The use of magnetics to apply pressure in an off-line process, such as an IR belt oven. With the appication of high magnetic permeable materials to the top side of the components, a controllable downward force can be applied with the use of electromagnets within the oven. Or, permanent magnets could also be positioned under the board, therefore minimizing additional tooling. Conceptually, this method seems sound, however the implications of magnetic fields to a non-operating memory and other sensative IC's has not yet been explored. Additional prototyping will be necessary for full investigation of this method.

Other areas which needs research are the life and performance boundaries which exist with the fine pitch component and Z-Axis epoxy system. The quality of the contact surfaces is critical for life testing. What effect will various passivation materials have on the integrity of the bond and how will the conductivity vary over real life testing such as vibration and temperature cycling?



The current material has passed the Bellcore specifications for electromigration, and surface insulation resistance, but will that change with subsequent life testing? The lead geometry for fine pitch devices has not yet been confirmed. A.I. can predict with a certain degree of accuracy, the contact geometry needed, but what is optimum for the end process and quality of the end product, needs to be determined by both the component manufacturer and the user. For the use of a completely new process, more restrictions on the component manufacturers may be required. Planarity of leads will be critical to ensure even and proper contact between the conductive particle and the respective lead and contact pad.

Remembering that this is a new technology which will enable advancements in SMT capability should expand the horizons of process limitations, and adaptation. It is important to realize that as an adhesives manufacturer it is possible to improve only our product characteristics based on results seen in testing, and the requests of our customers. The SMT and other solder influenced markets have created a need to consistently and proficiently mount components with lead pitch less than 25 mils. Our material technology allows such an interconnection to exist, however every system has its special considerations. It is the synthesis of those material advancements, with adaptations to current methods, and utilization of new ideas and processes, that will allow this technology to flourish. We propose a partnership approach to engineering, each company contributing its expertise in their respective areas, a logical and systematic approach to testing and evaluation, and proper funding, to make fine pitch interconnection at the surface mount level a reality. We look forward to working with you.