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ELECTRONIC MATERIALS — OUR FUTURE

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ELECTRONIC MATERIALS — OUR FUTURE

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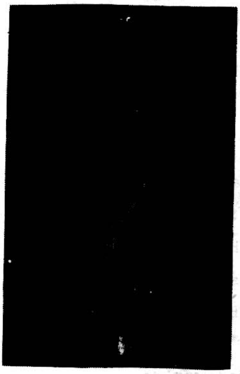

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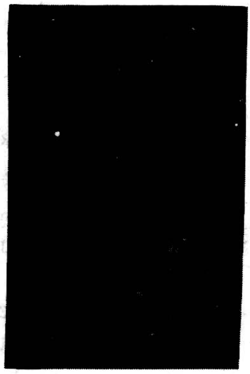

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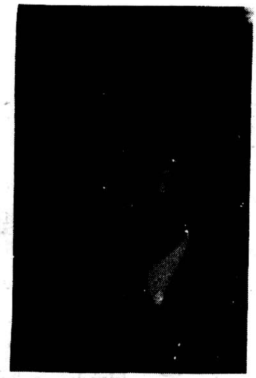

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PREFACE

The New Mexico Chapter of the Society for the Advancement of Material and Process Engineering is honored to host the 4th International SAMPE Electronic Materials and Processes Conference in Albuquerque, New Mexico. The theme for our conference is "Electronic Materials -- Our Future". Technological breakthroughs in electronic devices have become increasingly materials dependent. Thus, if we are to keep pace in the highly competitive technology, then Electronic Materials are "Our Future". In keeping with our conference theme, we have assembled a program with some of the most knowledgeable and technically respected people in the electronic materials field. Since SAMPE has dedicated itself to be a world leader in the electronic materials field, we feel this type of conference will once again prove that SAMPE is truly a society that will meet the needs of the entire materials family.

This conference will cover materials and processes for printed wiring boards, coatings and encapsulants, EMI shielding, electronic ceramics, surface mount technologies, and a very special session on the processing of superconductor materials. During prescribed times we will also offer exhibits from companies throughout the United States.

As you might expect, this type of conference would not exist without the help of many people, especially our dedicated conference committee. A special thanks to our new student chapter for all the help and volunteers they provided. A special thanks to Daun White for helping in setting up our exhibit area and also to the entire International Business Office staff. We would also like to thank our session chairmen, authors and exhibitors for a very successful and rewarding conference.

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SOLDERLESS ALTERNATIVES TO SURFACE MOUNT COMPONENT ATTACHMENT

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ABSTRACT

Solder has been the primary method of component attachment since the early days of radio. This tradition carries with it an overhead that becomes increasingly expensive as the degree of miniaturization increases. Solderless interconnect methods, however, are often overlooked or unfairly discounted as unreliable. Surprisingly, solderless connections can be mechanically superior and environmentally more robust than their soldered peers. This paper reviews various solderless interconnect techniques for surface mount applications and discusses their relative merits.

1. INTRODUCTION

Although convenient and readily available, soldering technology can quickly become very inconvenient when applied to dimensionally large or fine-pitch surface-mount packages or when contractually obligated to meet military electronics assembly quality requirements. Specifically, solder has these shortcomings: high temperature exposure of the component during solder reflow (a potential reliability impact), corrosive solvent exposure (fluxes, deoxidizers, and cleansers), sophisticated process control, labor/capital-intensive assembly, high degree of inspection (connection quality often subjective), and susceptibility to mechanical fatigue. Alternately, a solderless approach offers: inherent compliance to thermally induced dimensional changes, connection quality that is quantitative, and far less complicated and labor intensive assembly processes.

This paper will address the following categories of solderless interconnection: conductive epoxies, memory metals, elastomers, wire bonding, and button-board techniques. Table 1 illustrates the broad range of choices and their domestic sources.

Table 1. The Variety of Solderless Component Attachment Techniques Offers Many Choices

Categories	Techniques	Typical Use	Manufacturer
Epoxies	Silver Filled	Chip devices	Abelstik
	Gold Filled	Hybrids	Abelstik
	Unidirectional	Leadless Carriers	Uniax
Memory metals	Heat to Activate	Connector/Socket	Beta Phase
	Cool to Activate	Socket	Raychem
Elastomers	Metal Plated Silicon Stack	Key Pads	PCK Elastomerics
	Elastomer w/ Aggregate Fill	Test Socket	ATT
	Elastomer w/ Spring Contact	Test Socket	Rogers Corp.
Wire Bonding	Wire Bond Package to PWB	High Density	Westinghouse
Button Board	Compliant Spring in Carrier	Area Array Package	Cinch Connector

1.1 Conductive Epoxies

This approach is perhaps the most commonly used substitute for solder. Pin and socket (connectors) are of course more common but are not a surface-mount technique. Use of epoxies eliminates many of the process-related difficulties of solder, but has little impact on the design of the product, as shown in the implementation of a surface-mount chip component of Figure 1. Conductive epoxies are most often used within a hermetic package to attach integrated circuits or discrete chip capacitors/resistors. They are typically found as a silver filled epoxy but can also be obtained in a gold filled variety. A new class of epoxies having anisotropic properties that permit conduction in only one axis are also available and can be used to attach a fine pitch, high density, multicontact component.

1.1.1 Advantages

- Peaceful Coexistence. Conductive epoxies are often used on substrates requiring a mixture of wire bonded and surface mount chip components.

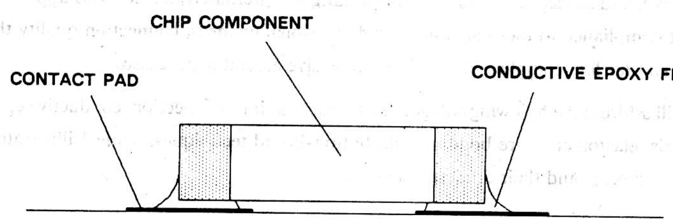

Figure 1. Chip components are similarly attached with epoxy as with solder but footprint pad dimensions can be tighter.

- Smaller Component Footprints. Since epoxy does not "wet" the way solder does, footprints of chip components may be less generous in pad area because the fillet spread can be more tightly controlled.
- Lower Curing Temperatures. Curing of most epoxies usually occurs at temperatures much lower than solder reflows (150°C compared to 280°C). In the case of unidirectional epoxies, attachment requires only a momentary pressure on the component while ultraviolet (UV) or low temperature cured.
- Better Fatigue Characteristics. By definition, epoxies are compliant, more fatigue resistant, and repairable with less likelihood of damage to adjacent components.

1.1.2 Disadvantages

- Environmental Susceptibility. A major disadvantage, particularly in military applications of the silver-filled variety, is its poor resistance to environment. Humid conditions under electrical bias will cause silver to grow dendrites, as do unprotected copper, nickel, and tin. One way around this is the use of gold-filled epoxies, but with more expense.
- Time Dependent Life. Although typically considered as the opportunity cost, shelf life of epoxies are limited and often require refrigerated storage at –40°C. Unless substantially automated, application, particularly for small components, can be labor intensive.

1.2 Memory Metals

Memory metals are a class of alloys (such as Nitinol) that change their crystalline phase when heated (or, for some, cooled) to a specific temperature. This shift in internal structure can induce tremendous forces and result in a mechanical advantage. Although the examples shown in Figures 2 and 3 are not directly surface mount related, they are illustrated here as examples of varied application that could be applied to surface mount technology.

Figure 2 uses the memory metal that changes state when cooled to liquid nitrogen temperatures. The socket member pressed into the printed wiring board (PWB) is made from beryllium copper, acts as an opening spring and is surrounded by a memory metal collar. When cooled, the memory metal enlarges and allows the Be/Cu socket to open against the memory metal collar, thus releasing the grip on the component's lead. Alternately, Figure 3 uses the memory metal in a backplane connector application that opens against a trough-shaped closing spring when heated to 85°C by a heating element integral to the flex circuit.

1.2.1 Advantages

- Gas Tight Connection. The primary advantage of memory metals are their ability to form gas-tight contacts without the use of solder. This is possible because the closing spring can exert up to twice the normal force on the contact than a conventional friction fit contact. Because temperature is used, tooless component attachment and release can be effected at low cost.

1.2.2 Disadvantages

- High PWB Real Estate Overhead. Unfortunately, current memory metal implementations are application specific and not directly applicable to high density component attachment. As

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