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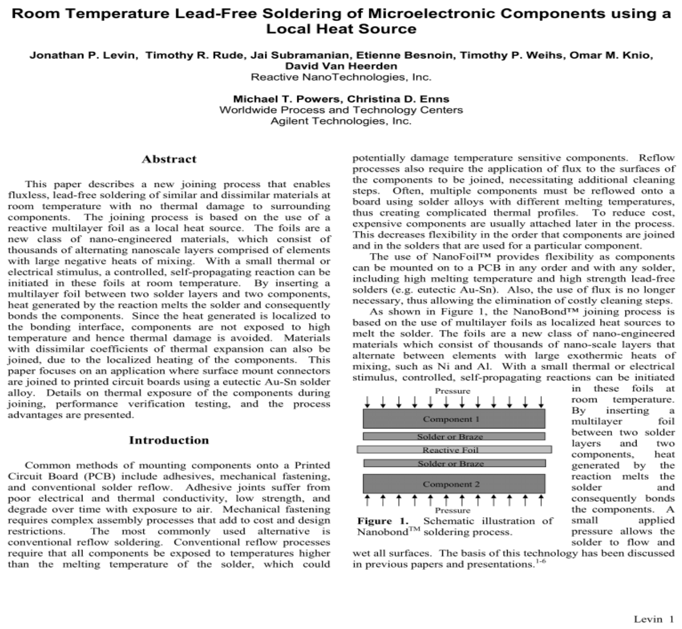

Room Temperature Lead-Free Soldering of Microelectronic Components using a Local Heat Source

Jonathan P. Levin, Timothy R. Rude, Jai Subramanian, Etienne Besnoin, Timothy P. Weihs, Omar M. Knio, David Van Heerden
Reactive NanoTechnologies, Inc.

Michael T. Powers, Christina D. Enns
Worldwide Process and Technology Centers
Agilent Technologies, Inc.

Abstract

This paper describes a new joining process that enables fluxless, lead-free soldering of similar and dissimilar materials at room temperature with no thermal damage to surrounding components. The joining process is based on the use of a reactive multilayer foil as a local heat source. The foils are a new class of nano-engineered materials, which consist of thousands of alternating nanoscale layers comprised of elements with large negative heats of mixing. With a small thermal or electrical stimulus, a controlled, self-propagating reaction can be initiated in these foils at room temperature. By inserting a multilayer foil between two solder layers and two components, heat generated by the reaction melts the solder and consequently bonds the components. Since the heat generated is localized to the bonding interface, components are not exposed to high temperature and hence thermal damage is avoided. Materials with dissimilar coefficients of thermal expansion can also be joined, due to the localized heating of the components. This paper focuses on an application where surface mount connectors are joined to printed circuit boards using a eutectic Au-Sn solder alloy. Details on thermal exposure of the components during joining, performance verification testing, and the process advantages are presented.

Introduction

Common methods of mounting components onto a Printed Circuit Board (PCB) include adhesives, mechanical fastening, and conventional solder reflow. Adhesive joints suffer from poor electrical and thermal conductivity, low strength, and degrade over time with exposure to air. Mechanical fastening requires complex assembly processes that add to cost and design restrictions. The most commonly used alternative is conventional reflow soldering. Conventional reflow processes require that all components be exposed to temperatures higher than the melting temperature of the solder, which could potentially damage temperature sensitive components. Reflow processes also require the application of flux to the surfaces of the components to be joined, necessitating additional cleaning steps. Often, multiple components must be reflowed onto a board using solder alloys with different melting temperatures, thus creating complicated thermal profiles. To reduce cost, expensive components are usually attached later in the process. This decreases flexibility in the order that components are joined and in the solders that are used for a particular component.

The use of NanoFoil™ provides flexibility as components can be mounted on to a PCB in any order and with any solder, including high melting temperature and high strength lead-free solders (e.g. eutectic Au-Sn). Also, the use of flux is no longer necessary, thus allowing the elimination of costly cleaning steps.

As shown in Figure 1, the NanoBond™ joining process is based on the use of multilayer foils as localized heat sources to melt the solder. The foils are a new class of nano-engineered materials which consist of thousands of nano-scale layers that alternate between elements with large exothermic heats of mixing, such as Ni and Al. With a small thermal or electrical stimulus, controlled, self-propagating reactions can be initiated in these foils at room temperature. By inserting a multilayer foil between two solder layers and two components, heat generated by the reaction melts the solder and consequently bonds the components. A small applied pressure allows the solder to flow and wet all surfaces. The basis of this technology has been discussed in previous papers and presentations.[1-6]

Figure 1. Schematic illustration of Nanobond™ soldering process.

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