

## After IBM's CCGA Exit, Suppliers Rush to Fill the Vacuum

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**T**he announcement by IBM to discontinue CCGA (Ceramic Column Grid Array) package production sent a ripple of shock and dismay throughout the aerospace, defense and high-power computing industries.

### A Cornerstone

IBM has been a cornerstone in the tiny CCGA market sector over the past 40 years. Why, then, does Big Blue want to stop supporting this package format which is critically important to its users?

In light of this action, who will be the beneficiaries of IBM's market exit?

### A Quiet Announcement Was Made

Xilinx, the largest fabless maker of FPGAs, historically depended on IBM's packaging services to fabricate its most powerful CCGA devices.

In a product change notice, Xilinx quietly announced it would shift ceramic package production to Kyocera in San Diego, Calif.

In early 2013, TopLine of Irvine, Calif., began manufacturing Pb90/Sn10 as well as Pb80/Sn20 copper-wrapped solder columns

in Orange County, Calif., to support customers requiring columns.

### New CCGA Suppliers

And in February 2014, Silicon Turnkey Solutions of Milpitas, Calif., announced it had licensed IBM's Pb90/Sn10 CCGA technology to provide column attachment and rework services.

Additionally, Six Sigma, also of Milpitas, is scrambling to cope with an increase in business for column attachment services created by IBM's exit.



The CCGA has become critical for the defense sector (U.S. Navy)

### CCGA Applications

Let's examine the applications where the CCGA package is preferred:

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**Fill the Vacuum (from 3)**

Ceramic substrates are used for microprocessor packages that operate in harsh environments. Ceramic CPUs must connect to a PC mother board (or card) along with other components.

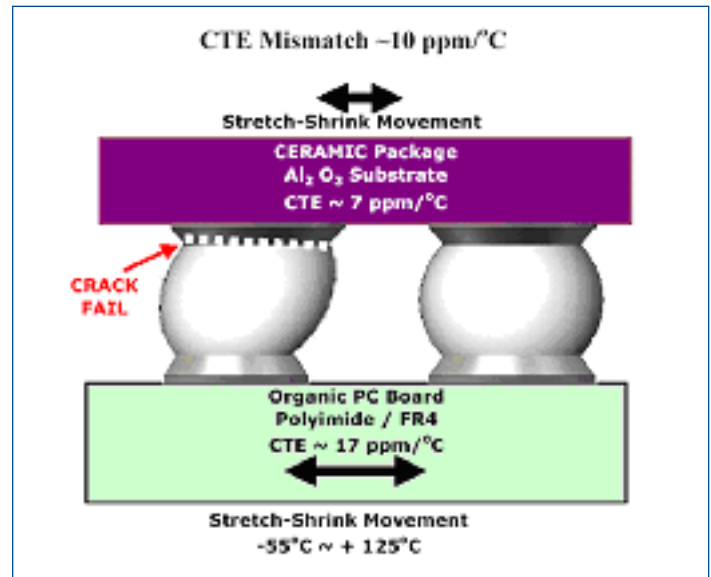
**Excellent Interconnects**

Solder columns are excellent interconnects for absorbing the CTE mismatch between large ceramic substrates (modules) and PC boards.

Ceramic and copper-clad PC boards expand and contract at different rates as temperatures change. As a result, ceramic modules and PC boards shrink, shift and move as temperatures cycle from hot to cold and cold to hot.

There is roughly a 10ppm/°C difference between the physical properties of ceramic materials and the physical properties of copper-clad FR4 (or polyimide) PC board materials.

*See page six*



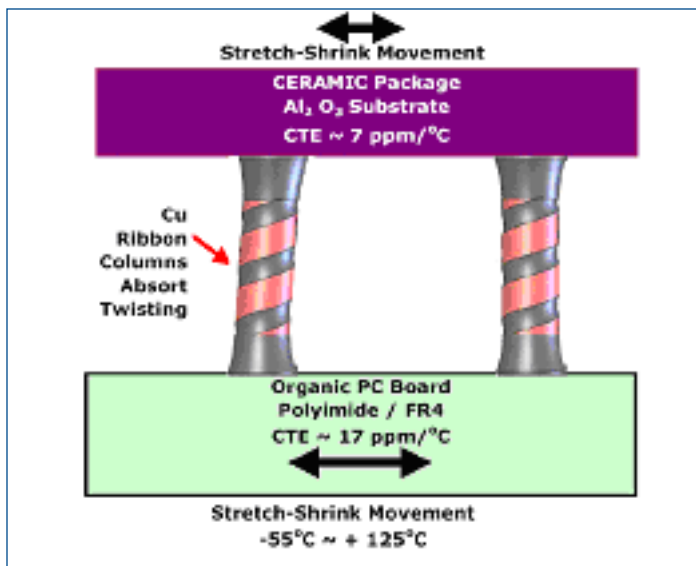
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**Fill the Vacuum (from 4)**



**Solder Balls Will Deform**

Solder balls, such as those found on standard BGA packages, will eventually deform, crack and delaminate when used as the interconnect on large ceramic modules.

Physical movements from corner-to-corner of a large ceramic module may exceed 3 mils (75µm)—about the thickness of a sheet of paper, as temperatures swing upward to +125°C and down to -40°C.

**Solder Columns 10X More Reliable**

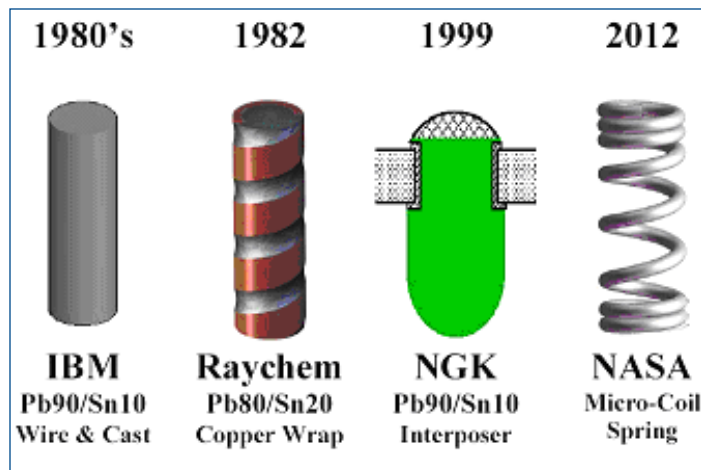
Solder columns are 10X more reliable than solder balls in extending the operating life of large ceramic modules. Applications in space are mission critical where it is impossible to repair a faulty component.

Cylindrically shaped, high-lead solder columns behave as malleable interconnects between a ceramic microprocessor substrate and a PC board.

The soft solder columns absorb continual movement as the ceramic and board materials expand and contract over changes in temperature.

**Reviewing the History**

Let's review the history of solder columns. By looking at the time table below, it is interesting to see how little innovation there has been over the past 35 years.



At the start of 1980, IBM launched the commercialization of CCGA packages by inventing the columns using high lead Pb90/Sn10 solder wire interconnections.

Columns are attached to the ceramic modules with lower temperature Sn63/Pb37 solder paste. IBM also invented the CAST column to support high-volume production where Pb90 solder is melted and cast into a column simultaneously while attaching it to the ceramic substrate.

**BAE Systems Enters the Market**

Two decades later, BAE Systems licensed IBM's technology to offer Pb90/Sn10 column attachment services.

In 1983, Raychem figured out a better mousetrap by inventing an enhanced column. Raychem's column was commercialized with Pb80/Sn20 solder wire wrapped with a thick spiral layer of copper ribbon as the interconnect.

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After 13 years of producing solder columns, Raychem left the business and licensed its technology to Winslow's Six Sigma Division in 1996. Six Sigma supplies Pb80/Sn20 copper-wrapped columns.

### **NGK Adds Interposer**

In 1999, NGK, Japan, filed a design patent for a Pb90/Sn10 solder column interposer (SCI) system. Only a handful of device makers have incorporated NGK's interposer design into their package and this technology has apparently failed to gain market traction.

In 2012, NASA filed a patent for a novel micro-coil spring interconnect for CCGA packages. Last July, NASA sold and transferred its spring technology to TopLine under a worldwide, exclusive agreement.

*Mr. Hart is president and CEO of both Topline and Mirror Semiconductor. He has been involved with semiconductor packaging for more than 30 years.*

*He is a graduate of California State University, Long Beach, where he earned a degree in electrical engineering.*

*As our executive editor-at-large, he is a frequent contributor to TAP TIMES and a visitor to many trade shows. For more details, visit [ccga.co](http://ccga.co) (not com).*

The second part of this article on the benchtop attachment of columns will appear in the August issue.

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## Attaching Columns to CCGA Packages

*Second in the Series*

**O**nly a few unique apparatus have been invented over the past 40 years to attach solder columns to CCGA (Ceramic Column Grid Array) packages.

Unlike the attachment of solder balls to BGA (Ball Grid Arrays), column attachment is an enigma. Columns are cylindrically shaped, and require special handling, placement and reflow onto CCGA substrates. Solder balls are spherically shaped and easily roll.

### **An Array of Holes**

In manual and semi-manual systems, solder balls typically drop through a stainless-steel stencil with an array of holes that match the pattern of the BGA pads.

Some ball placement machines have a vacuum pick up system for high volume assembly, while others employ a laser system to place and reflow solder balls one at a time.

### **Ball Attach Systems Being Improved**

Ball attachment systems made by well-known equipment manufacturers, Shibuya for example, have been on the market for decades and are continuously improved by an army of engineers and technical people.

### **IBM Pioneered Mass Assembly**

IBM, the pioneer of CCGA mass assembly, spent millions of dollars and countless man-years developing a clever automated system to attach columns.

A few patents have also been awarded to other companies for various complex column attach systems involving vacuum.

### **Low-Volume Assembly**

For low-volume assembly, benchtop fixtures made of graphite or molybdenum have been used over the past four decades. These fixtures have been comprised of an array pattern of holes that precisely correspond to the pads on the CCGA substrate.

Typically, solder columns are manually loaded into the graphite fixture using tweezers. The task to load a fixture fully is time consuming and labor-intensive.

### **Placed One at a Time**

Columns are placed one at a time into the graphite fixture. A skilled operator might achieve cycle speeds of only one column every two seconds. The time to load 1752 solder columns (Xilinx's high-end FPGA into a graphite fixture) takes about an hour.

Shockingly, one skilled operator can load only 130 CCGA fixtures per month, allowing for fatigue, rework, lunch breaks, etc.

### **Manual Attachment**

During the past 15 years, Six-Sigma has built a service business by manually attaching copper-wrapped Pb80/Sn20 columns using graphite fixtures. Over a similar timeframe, BAE in Manassas, Va., has offered attachment services for Pb90/Sn10 columns.

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**Attaching Columns (from 6)**

In January, STS announced it had bought IBM's column attach tools and technology license for Pb90/Sn10 columns.

**Pin-Pack Patent Filed by TopLine**

This year, TopLine Corp. filed a patent for its new, proprietary *Pin-Pack* column dispensing system. Columns are pre-loaded in a plastic cassette and the cassette mounts onto a graphite fixture.

The columns are held in place by a single layer of tacky adhesive tape. When the tacky tape is peeled back with fingers or with a small hand tool, the columns gently fall by means of gravity into the array pattern of holes in the graphite fixture.

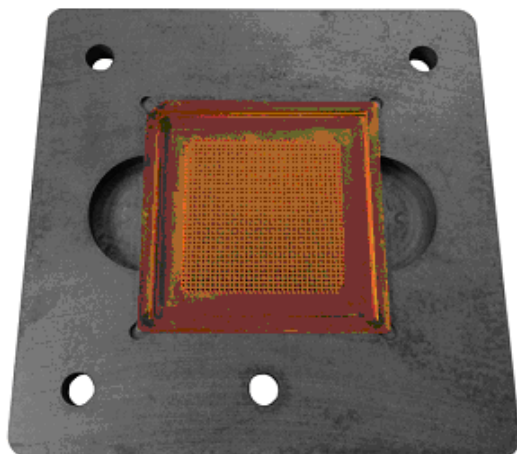
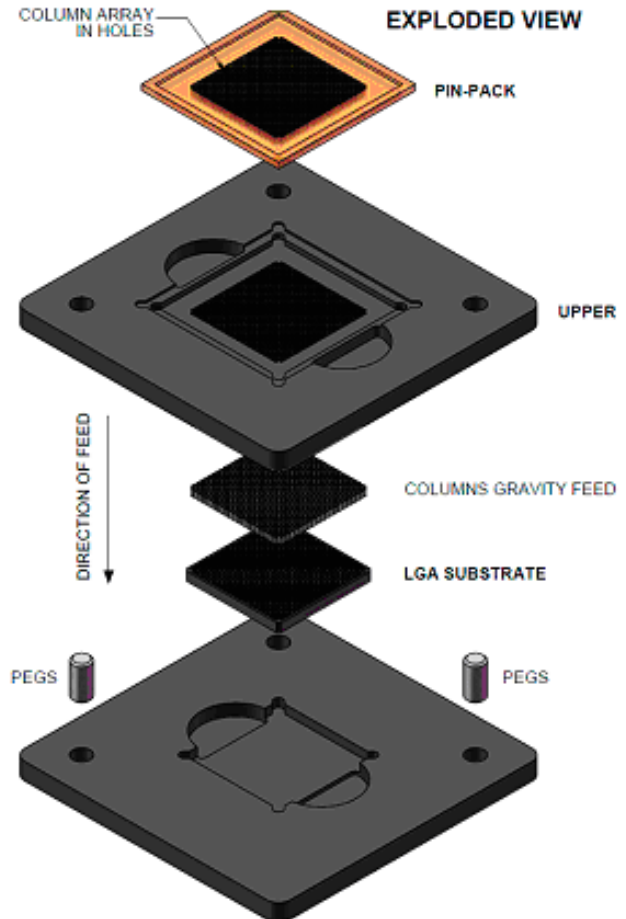
**Less than One Minute to Transfer**

It takes less than a minute for 1752 columns to transfer from the *Pin-Pack* cassette and land in a layer of solder paste that has been applied to the CCGA substrate sitting face up in the bottom of the graphite fixture.

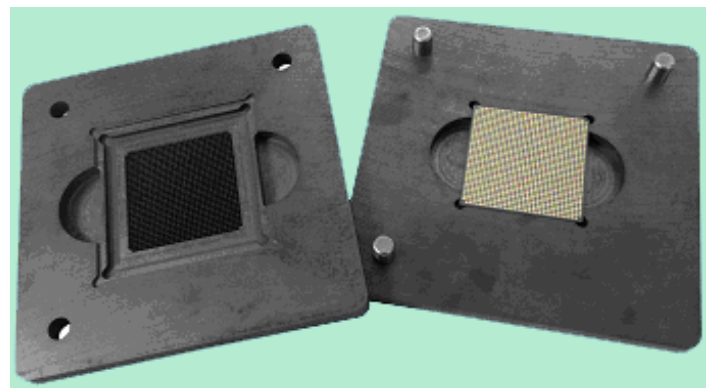
With the cassette loading system, columns can be loaded to thousands of CCGA fixtures per month, per operator.

All versions of columns including Pb80/Sn20 with copper wrap, Pb90/Sn10 IBM style and NASA Micro-coil Springs are available in the *Pin-Pack* cassette dispensing system. The cassette is thrown away or recycled after the columns are depleted.

*Exploded View of Graphite Fixture Using Pin-Pack System*



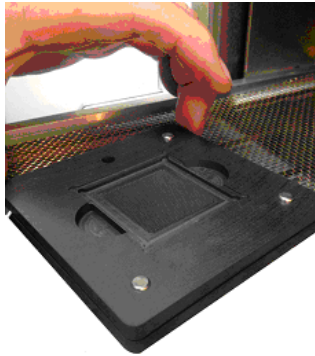
*Pin-Pack cassette mounted on a graphite fixture*



*Example of two-piece graphite fixture with MicroSemi (Actel) 1152 column CCGA (See next page)*

### **Attaching Columns (from 7)**

Typical graphite fixtures consist of a two-piece toolset. The inset graphic holds the CCGA substrates.



The graphic on page 7 presents an array pattern of holes that keep each column upright during assembly. Three metal positioning pegs align the top graphite to the bottom graphite.

For best results, use a vapor-phase reflow oven with Solvay Golden LS215 solution or a 12-zone convection oven.

### **Aerospace/Military Applications**

For aerospace or military/defense applications, normal eutectic Sn63/Pb37 solder paste is applied to the CCGA substrate when attaching columns, as well as when reflowing the completed CCGA device to a PC board.

*Mr. Hart is president and CEO of TopLine. He has been involved with semiconductor packaging for more than three decades.*

*He is a graduate of California State University, Long Beach, where he earned a degree in electrical engineering.*

*As executive editor-at-large, Mr. Hart is a frequent contributor to TAP TIMES. A follow-up article on lead-free benchtop attachment will appear in a future issue.*

**Details at [ccga.co](http://ccga.co) (not com)**