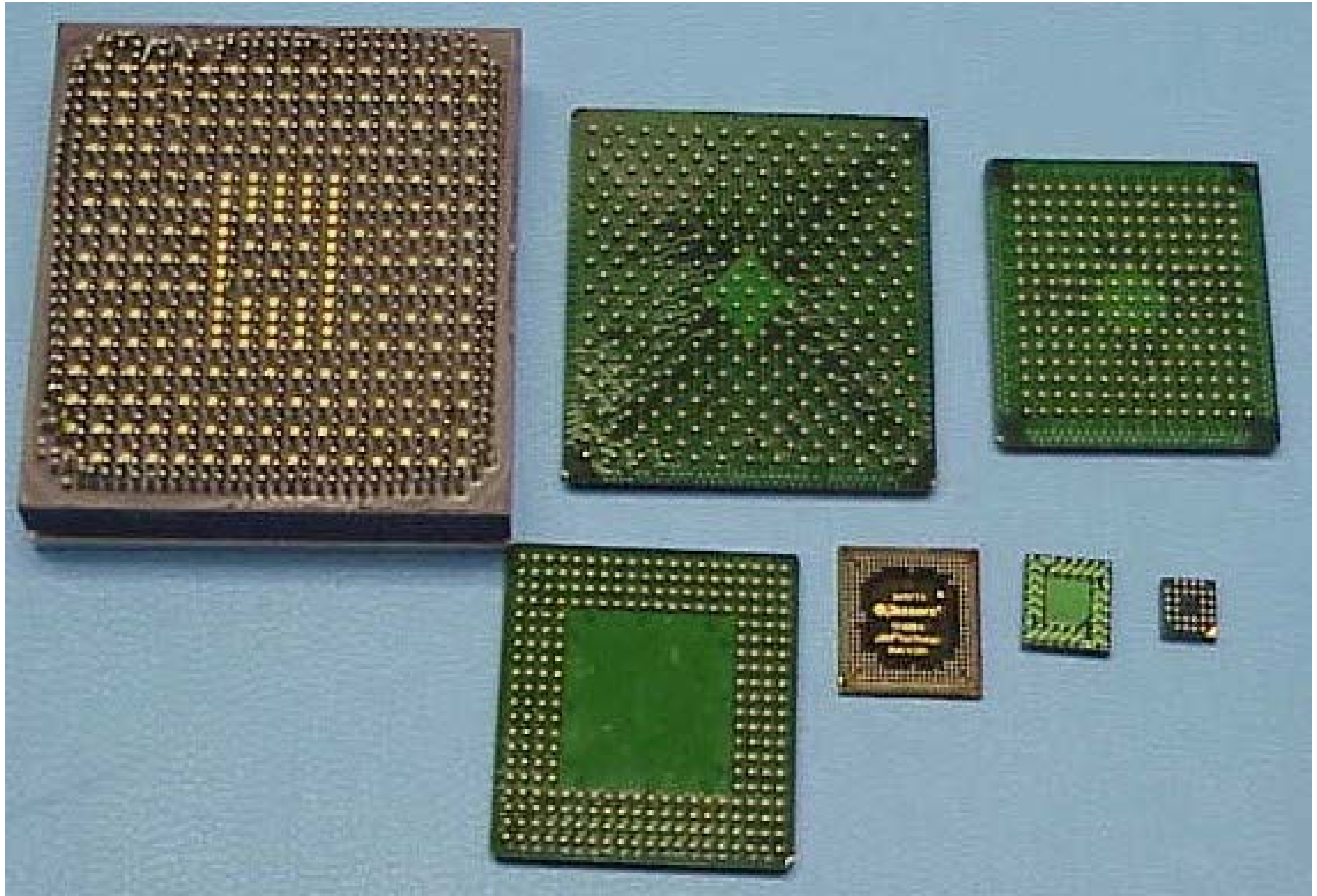

BGA/CSP Reballing

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The trend in the electronics interconnect industry towards "Area Array Packages" type packages (BGA's, CSP's, CGA's etc.) and away from high pin count leaded packages (primarily Quad Flat Packs) has increased dramatically over the last several years. The primary reasons for this are:

1. High BGA I/O (Input/Output) density (up to and exceeding 1000 I/O's, compared with the largest QFP packages of 304 pins).
2. Increased reliability/robustness in all PCB assembly processes.
3. Improved electrical and thermal characteristics area array packages
4. Higher first pass yield over conventional QFP's.
5. Easier and more reliable rework if the proper equipment is used
6. The ability to touch up (re-ball) and re-use BGA's after removal in the rework process.

Ball Grid Array packages are fundamentally different from other types of Surface Mount Devices (SMD's) in that they do not allow visual inspection of solder joints unless the user has very specialized equipment. See figure 7. This is due to the interconnects being hidden "under" the package. Therefore all parameters of the BGA rework process, including the consistency of the interconnect balls on the package must be precise and consistent. For example, in the re-balling process of a 1000 I/O package, if just one ball size is incorrect (a 99.9% accuracy), the rework will look good but will not work properly. Even under simple 2D X Ray, an insufficient ball size will not be noticeable. It will require a much more time consuming 3 dimensional X Ray analysis to reveal that the solder ball was to small and therefore did not make contact with the corresponding pad. So, the re-balling process must be 100%, there is no room for error.

"Common" Ball Grid Array Packages

Plastic Ball Grid Arrays (PBGA) – Figure 2.

The PBGA is the most common of the BGA package types. It uses an overmolded resin substrate to encapsulate the die/chip and either SN63/PB37 eutectic solder bumps or SN62/PB36/AG2 solder bumps are used for attachment to the mounting site. See figure 5 & 6. These solder bumps collapse during reflow creating the electro-mechanical connection to the PCB. Most PBGA's use a solder bump diameter of .030" so the same 0.030" size is best for re-balling. PBGA overmold epoxies are generally moisture sensitive (hydroscopic) in that they absorb moisture from the surrounding environment. This can lead to a condition termed "popcorning" during the reflow/re-balling process as the entrapped moisture turns to steam and expands. Popcorning is the delamination of the plastic packaging material or the delamination of the plastic material from the die itself and needs to be avoided at all costs. Therefore dry storage or pre-baking the PBGA in an oven @ 125°C (257°F) for 24 hours is necessary for the re-balling process.

Micro BGA's and CSP's (Chip Scale Packages)

Micro BGA's and CSP's are actually the same thing! Tessera Inc. trademarked the term µBGA, and CSP is the term used by the rest of the industry. A µBGA or CSP is commonly defined as a package that is no more that 1.2 times the size of the actually chip in the package. Pitch, or the center-to-center bump/ball spacing, is usually less than a PBGA, sometimes down to as little as .5mm or .020". Therefore the re-balling process is a little more difficult than standard BGA's however all the same process parameters apply. µBGA's and CSP are also subject to moisture absorption and related defects and the necessary precautions outlined above should be taken.

Ceramic Ball Grid Arrays (CBGA) – Figure 3.

The CBGA package employs a "flip-chip" technology where an actual chip is bonded to the top of a fired ceramic substrate using a technology pioneered by IBM called "C4". C4 is an acronym meaning "controlled collapsible current conductor". CBGAs use an array of .035" (.89mm) diameter SN10/PB90 (melting point 325°C/617°F) solder balls which have been joined to the bottom of the ceramic substrate using eutectic solder. During reflow the eutectic solder at the ball/substrate and the ball/PCB complete the electro/mechanical connection. Hence, it is required to screen solder paste onto the PCB land pattern or onto the .035" high-temperature solder balls to facilitate the bond. The high melting point solder balls do not reflow, but instead maintain a .035" standoff between the substrate and PCB. These type connections provide the required flexure to accommodate the thermal coefficient of expansion (TCE) mismatch between the ceramic substrate and the PCB.

Ceramic Column Grid Array (CCGA) – Figure 4.

The CCGA is a variation on the CBGA in that instead of using non-eutectic high temperature solder balls it employs solder columns measuring .020" in diameter and between .050" and .087" in height. These solder columns are designed to provide greater flexure to accommodate high power dissipation levels. Re-balling is NOT recommended for these package types due to their extreme complexity. However, due to the high cost, it may prove to be cost effective, even with the longer processing time and lower yield.

Figure 1 – BGA Assortment

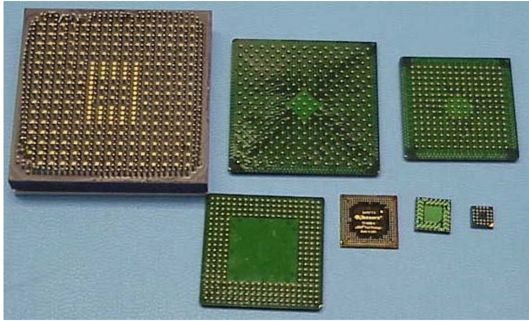

Figure 2 – PBGA solder spheres

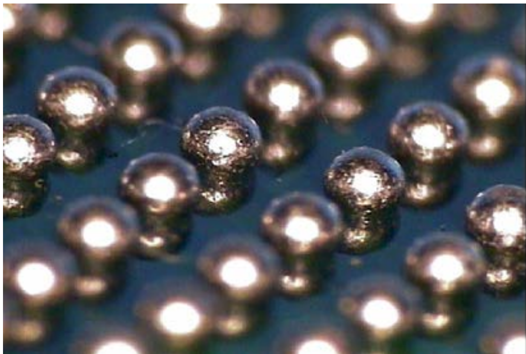

Figure 3 – CBGA solder spheres

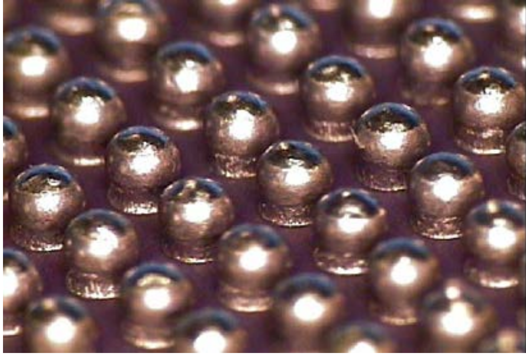

Figure 4 – CCGA columns

Figure 5 – Internal construction

Figure 6 – Internal construction

Figure 7 – Typical PBGA attach

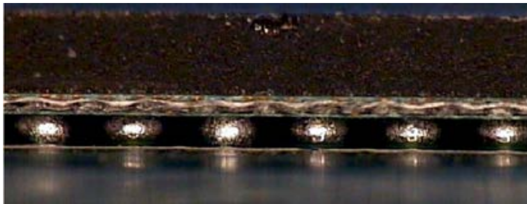

Figure 8 – Sample thermocouple attach

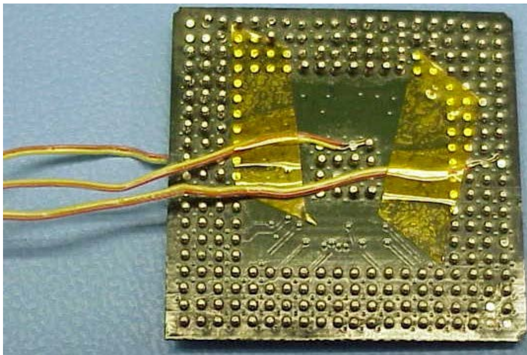

Figure 9 – Typical nozzle selection

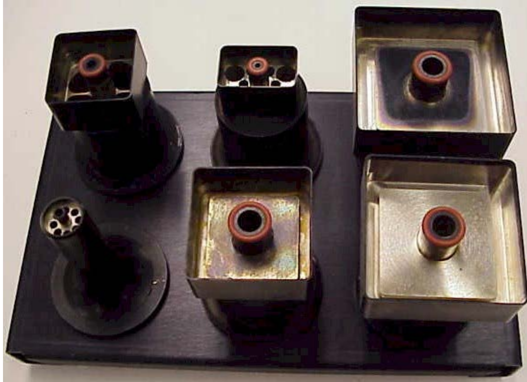

Figure 10 – Plastic mini-stencil

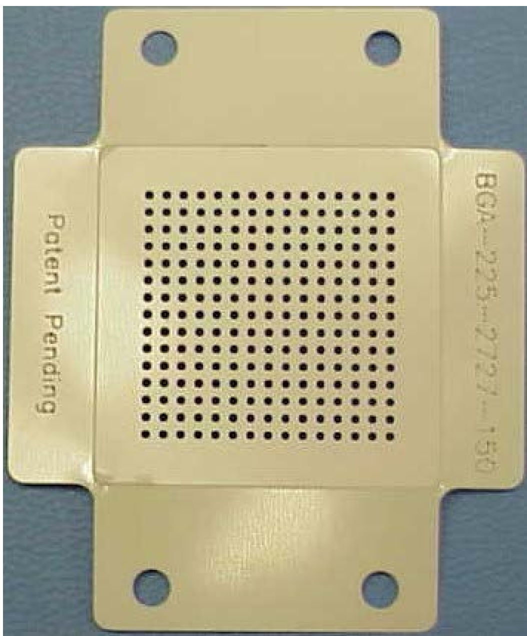

Figure 11 – Stenciling Kit

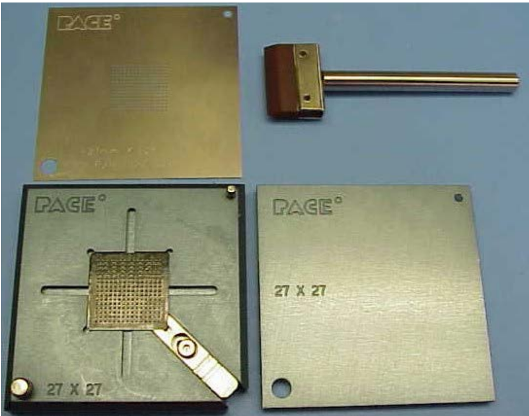

Figure 12 – Reballing fixture