There is a growing demand for equipment and processes that will restore defective solder balls on surface mount (SMT) devices. The three most common reasons for restoration are: to repair missing or bridged solder bumps created during the bumping process; rework parts that were damaged during assembly; or to replace lead-free spheres with lead-based spheres for specialty applications (reballing).

**Repair.** There is always some yield loss associated with the common solder bumping technologies — paste printing, electroplating, or sphere transfer. For some applications, bump yield losses have a profound effect on the die yields and therefore also affect the overall profit margin. This is especially relevant when the device is of very high value, or the I/O count per die is high. By implementing an inline repair station into the bumping process, yields can be dramatically increased.

**Rework.** During the assembly process, defective SMT parts (BGA, CSP, and packaged flip chip parts) are often scrapped due to defects in the solder interconnects. Recovery of these devices requires disassembly and then rework of the individual components. This rework includes removal of the damaged solder balls from both the device and substrate and then placing new solder balls onto the part. A flexible rework tool, which can remove and replace defective solder balls, will lead to a significant increase in overall system yields.

**Reballing.** The electronics industry has eliminated metallic lead (Pb) from nearly all components and processes (RoHS compliance). Most backend packaging companies which produce BGA packages have switched all of their production capacity to lead-free alloys (SnAgCu), leaving specialty applications like defense, aerospace, and medical without the "qualified" lead-based BGAs required for their systems. Because of this need, it is important to have a flexible process to remove and then replace the lead-free spheres with the higher reliability and qualified lead-based alloys. A single technique that can accomplish all three restoration processes — repair, rework, and reballing — involves the use of the SB2 laser-based bumping system. The tool removes and replaces the solder bump utilizing a localized heating source to selectively melt a single solder sphere, then uses a vacuum to remove that molten solder material from the device (wafer, chip, or package) through a capillary tube. This same tool then drops a new preformed solder sphere onto that bond pad while simultaneously reflowing the sphere using a laser (solder jetting).

The basic principle behind the operation of the SB2-M...
tool is to: align the capillary tube to the solder sphere that needs to be removed. The heated capillary head is lowered down toward the solder ball and vacuum is applied to the capillary to suck the molten solder up and out through the capillary. To replace the balls, the tool is realigned to the bond pads, and a prefomed solder sphere is singulated within the bondhead and dropped down through the capillary. As the sphere approaches the bond pad, a laser beam is pulsed within the capillary, which refloows the solder sphere just as it reaches the pad (solder jetting). The bondhead is then repositioned over the next pad and the process is repeated. Reballing speeds of up to 6-8 balls per second have been realized using this technology.

Analysis of the solder joints which are created using this laser-based method has shown comparable ball shear forces to that observed for the original part. This method has the advantage over traditional rework methods in that the very short laser pulse (1-20 millisecond) creates only a minimal amount of additional intermetallics. This results in restored parts that have the same reliability observed for the original part. In addition, localized laser heating significantly reduces the amount of stress that can build up in a system.

The versatility of this tool is realized by its wide flexibility in solder alloy composition and the ability to accept devices with different sizes and form factors. Solder balls of nearly any solder alloy composition and size can be both removed and replaced using this technology. Solder balls as small as 150µm and as large as 760µm are currently being deposited using the repair and rework tool in volume applications. The low cost structure of this tool is realized in its versatility used to repair, rework, and reball solder interconnects.

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