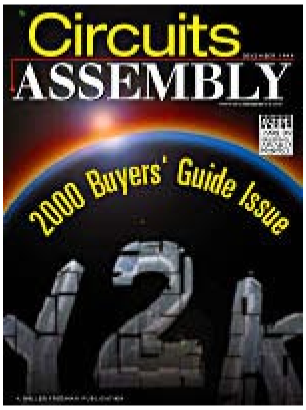

ON THE FOREFRONT

Coolest Thing Since Sliced Bread

By Phil Zarrow

If there is one area of surface mount assembly that is screaming for automation, it is post-reflow inspection. Manual inspection of PCB assemblies is slow, tedious, subjective and distraught with error. Have you ever manually inspected a PCB, particularly a moderately dense one? Need I say more? Somehow, I doubt you are thinking of making a career move toward becoming a board inspector.

As one walks through the halls of major trade shows, such as SMTA International, Productronica, APEX and various Nepcon shows, the sheer number of companies involved in the development and manufacture of automated optical inspection (AOI) equipment is overwhelming. If we project the path of equipment development, AOI is the big area of focus of automation. This equipment examines the soldered joint with automated vision or lasers.

On the other hand, if we look at the direction of packaging, Controlled Collapse Chip Carrier connection (C5), such as ball grid arrays (BGA) and chip-scale packages (CSP), as well as Controlled Collapse Chip Connection (C4) or flip chip, is the growing trend. Logically, we will see a strong decline in the number of leaded IC packages as the high I/O demands require the aforementioned controlled collapse array packages. Likewise, we will also see a decline in the number of discrete components on boards succumbing to embedded component technologies. See the dichotomy here? We will have, in the next two to three years, improved technology to inspect at outboard solder interconnections and fewer such interconnections at which to look.

Obviously, discretes, quad flat packs (QFPs) and their relatives are not going away, and there is a definite demand for AOI. Despite such aforementioned predictions of change, the requirement will linger for quite some time—not unlike wavesoldering.

Since the introduction of the plastic ball grid array (PBGA) by Motorola in the early 1990s, and the emergence of array packages, the question has always been how to inspect the interconnections. The original, obvious answer was x-ray, and there is a vast array of x-ray equipment, as well as laminography equipment, available to our industry. X-ray has its limitations. There is a lot of "gray area" (pun intended) with x-ray inspection. With array packages, detection of solder bridging is fairly straightforward. X-ray is also a non-destructive method of detecting misalignment. However, defects like opens and voids are more difficult to discern, even with the high resolution, high-priced equipment. Destructive testing, such as pull tests and cross sectioning, is exactly that—destructive—and, therefore, somewhat limited. If only we could peer under the package and actually see the solder joints.

Now we can actually see under the array packages to visually examine the solder joints and see many other critical things. ERSA, a German manufacturer mostly known for its soldering equipment, has introduced the ERSAscope Inspection System 3000, a high-powered microscope system that allows the user to actually see underneath a BGA, CSP and even a flip chip (Figure 1).

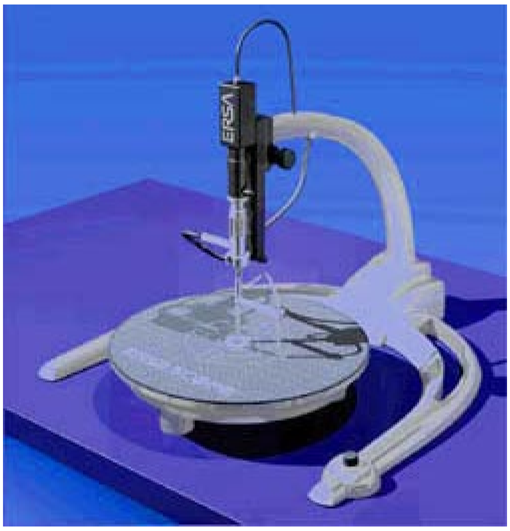

FIGURE 1:ERSAscope 3000 inspection system light source.

The heart of the system is a two-component head comprised of a fiber-optic light source and an optical instrument head mounted above an extremely accurate X-Y table where the subject PCB assembly is held. The scope, containing over 30 internal lenses and yielding up to 350x magnification, is about 0.060-in. in diameter at PCB level and contains a prism to afford a 90-degree view angle. To examine a BGA, the head is lowered to the component with the magnifier scope on one side of the component and the light source backlighting from the other side. By scanning along the component, the solder joints can be examined row by row. By adjusting the field-of-view, internal interconnections can be seen and evaluated. All of this is projected on a flat screen monitor via a high-resolution CCD color camera incorporated into the scope. The user is actually seeing the joint structure, surface structure and whether or not bridges are present.

By using dropdown-measuring tools incorporated in the software, actual measurements can be made. The actual standoff height, as well as degree of warpage, can be easily determined. The software portion of the system is pretty remarkable in its own right. Besides allowing for absolute and relative measurement, there is an image databank that can be accessed. This allows the user to reference known good conditions (or bad conditions) for real-time reference to the pieces being inspected. This takes the subjectivity element out of inspection.

I recently had the opportunity to put the $25,000 ERSAscope Inspection System 3000 through its paces during a visit to ERSA's North American facility in Old Lyme, CT. Besides the samples they had on hand, I brought a few PCB assemblies from my collection with me. I found the system easy to use and the software straightforward and impressive. We threw everything at it—ball grid arrays, column grid arrays, a 148-bump chip scale package and 96-bump flip chip. I was able to assess and measure everything I would want to on an interconnected array package. I looked at QFPs, TSOPs and TQFPs as well. I was able to analyze solder joints like I've never been able to before. I was like a kid in a candy store.

But, wait, there's more! The 350-power magnification, with a very small footprint and versatile lighting, makes for a very powerful package. Cross sectional images of joint formation of gull-wing, J-leaded and discrete terminations were as useful as actual (destructive) cross sectioning of the joints in determining heel and toe fillet formation and wetting angle. Height, width, radius and angle measurements are all accomplished with a "click of the mouse" to within ±0.01 mm. This really is the best thing since sliced solder joints.

With this tool, one can see solder joint cracks in connections that are inside, outside or under the component body (Figure 2). You can see whether there is micro-cracking of the component body (popcorn effect) without removing the component. Concerned about whether or not there is flux residue trapped under the component after soldering? Just take a look.

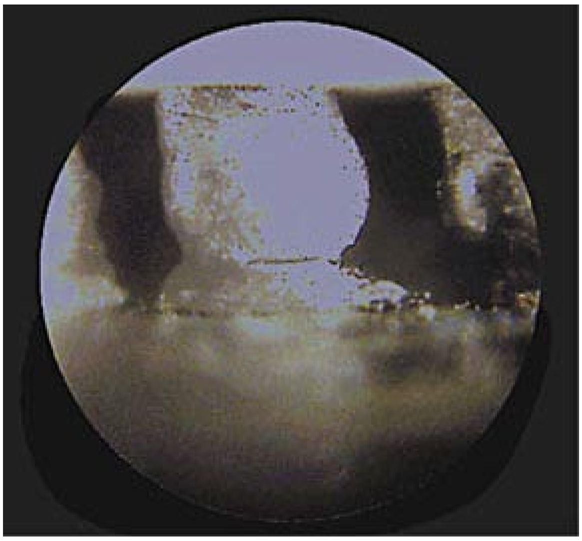

FIGURE 2:Image of a cracked ball.

The scope head can be interchanged with a magniscope that allows top view and 180-degree angled inspection, again at up to 350x magnification. I found myself looking at post-print solder paste—at the actual solder balls (typically 35µm in diameter or less). I examined wire bonds (1 mil diameter wire). I inspected the integrity of the apertures in a stencil. All of this is finitely measurable and allows the system to be used for post-print inspection with actual height measurement, pre-placement component lead coplanarity, via-hole diameter and via cleanliness, solder mask thickness and alignment, conformal coating thickness, adhesive deposition parameters…the possibilities go on and on.

As long-time readers of this column will attest, I rarely get this enthused about a particular piece of equipment or peripheral. However, this system is impressive and unique. It has no peers. It allows measurement of solder joint volume, fillet shape and alignment, surface uniformity, integrity and grain structure, as well as detection of PCB surface anomalies. It is the first system that I've seen in a long time that may be indispensable. No surface-mount assembly process should be without one.

Remember, we're all in this together.

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