Topic 1: Trace Encapsulation in LPISM Spray Applications

An understanding of trace encapsulation will help you to better understand why spray systems represent the state of the art in coating applications. The following information is written in simple terms…for a more technical discussion, contact an Argus process engineer (see bottom of this page).

On a printed wire board (PWB), a "trace" is a line of copper that runs along the surface of the substrate material to create an electrical circuit. A trace is analogous to a wire cord that runs from a lamp to an electrical outlet, the wire cord containing the copper wiring that completes the circuit. "Encapsulation" refers to the coating…in this case, liquid photo-imageable solder mask (LPISM)…that completely covers the exposed copper trace. Think of it as the plastic or rubber coat that covers the copper wiring that is inside the lamp cord. A term like "excellent encapsulation," means that LPISM has completely covered the traces with a uniform coating.

Early attempts to spray LPISM gave spray technologies a reputation for not being able to encapsulate high traces. The reason for this was that LPISM "inks" were not developed strictly for spray applications and those that were available (for screening or curtain coating, for example) had to be heavily diluted and this heavily diluted mix tended to bleed off the traces. That's the problem of encapsulation…how do you keep the LPISM from simply bleeding off the traces before it dries? **Argus International developed a unique technology to deal with this issue…a sprayer unit featuring a heated spray gun that feeds a wet PWB into an infrared quick-tack-dry oven….** But before that is explained, you have to understand a little about "viscosity" and "solids content."

The easiest way to think of "viscosity" is to think of the "gooiness" of a liquid. For example, molasses is gooier than water, and if you poured them both over a rounded surface, the water would simply run off while the molasses would move very slowly over the surface. And that is essentially what is being accomplished when spraying an LPISM liquid over copper traces. Like molasses, LPISM is very viscous, and it needs to be kept as viscous as possible so that it won't bleed off the traces when sprayed. But the only way that it can be sprayed is by diluting it with a solvent.

Now, before it is diluted, think of the LPISM as a solid. If that were the case, it would consist entirely of the solid material. We would describe this as having a "solids content" of 100%. As solvent is added, the LPISM is diluted so that it has a solids content of something less than 100%. The more solvent that is used, the lower the solids content of the LPISM, and vice versa. The challenge then is to spray LPISM at the highest possible solids content, then set and dry it very quickly before it bleeds off the traces.

To do this, the Argus Spray Application System heats both the single spray gun and atomization air, momentarily dropping the viscosity of the LPISM during the spray operation. This is extremely important because we can start with LPISM that has high solids content. LPISMs with solids content of over 60% are routinely sprayed, and spraying materials with solids content exceeding 70% are becoming feasible on Argus equipment. By contrast, our competitors can spray only 40-50% solids content.

So, in summary, think of LPISM as a gooey liquid trying to run off the traces. The Argus Spray Application System lays down a more viscous liquid that sets and dries in four minutes (when the spray unit is combined with the Argus tack dry oven). Compare that to Argus' competitors that spray a much less viscous LPISM, then take 45-60 minutes to dry in a conventional oven, and you will begin to understand how the Argus System better addresses the issue of spray encapsulation.

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Topic 2: The Advantages of Argus Hot Air Solder Leveling (HASL)

Hot Air Solder Leveling (HASL) is a relatively complex subject relating to the complete board manufacturing cycle. At Argus we receive a continuous stream of questions regarding various aspects of HASL processes and equipment. Discussed below are some of the Argus features that address the most commonly asked questions.

System Operation is strictly by the numbers. All operating parameters are precisely regulated. Air knives are fixed to eliminate uncontrolled variables. Air pressure is set by regulators that precisely control the air flow throughout the process cycle.

Short Stop of vertical travel is **a unique feature** that automatically minimizes the upward arm travel. This allows short boards to stop within easy reach of the operator while reducing the cycle time.

Superior Exhaust System structure is designed to provide internal ducting of exhaust fumes directly from the air knife manifold. The ducting also traps solder particles before they leave with the exhaust air.

Board Guides hold the board precisely between the air knives to minimize flutter and maintain uniformity. They are adjustable and removable without the use of tools.

Air Knives play a key role in the HAL operation. Argus' air nozzle geometry is designed for low turbulence and even flows. **An exclusive feature** is that the air knife assembly is factory preset and does not require any field adjustment. The working surfaces are hardened stainless steel to ensure long life and repeatable operation.

*** * * Argus air knives do not require replacement for at least 7-10 years of operation. * * ***

Up Speed is an important ingredient in the quest for even solder coating. The faster and more uniform the speed, the better the coating. The HAL5224 arm drive is powered by a regulated DC drive that gives uniform speed from the beginning to the end of travel. The maximum speed is 180 feet per minute. The high speed minimizes "snap-back" and "tear-drop" effects in the solder coating.

Uniform Solder Thickness across the board is the key to high yields in surface mount soldering. Low standard deviations (170 micro-inches) over the full range of solder thickness specifications are a result of the Argus HAL5224's extensive control capabilities.

High Throughput / High Yield production rate of 300 panels per hour. Options are available for flexible circuits and thin surface mount applications.

Maintenance is a major concern of any production operation. The Argus HAL5224 system requires an average of 30-45 minutes per shift because low maintenance is an integral part of the design. The solder pot area is accessible in a few seconds and the air knives lift out without any tools. Solder residue is simply brushed back into the pot and flux residue is washed away with soap and water. All heaters have low power density and high contact area giving thousands of hours of trouble free operation.

Discussions we've had in the field with owners of competitive brands of hot air levelers have reported losing two hours per shift to maintenance, along with one additional eight-hour day per week devoted just to maintenance. That adds up to sixteen (16) hours of production downtime per week which, in turn, adds up to 800 hours of downtime per year. On a one-shift operation, that is TWENTY LOST WEEKS per year! At 45 minutes per shift, the Argus HAL requires maintenance of only 3.75 hours per week or 187.5 hours per year. Simply put, the Argus HAL can be in production more than four times as much as some of our competitors due to maintenance considerations.

Solder Refinement Procedure is integrated into the design of every Argus HAL. A unique heating technique makes the tin-copper compound more buoyant which causes it to float to the top of the pot. Once the tin-copper "slush" is concentrated at the top, it is simply removed and sent for metal recovery. A procedure recommended by Argus as "Standby" gives the customer the ability to maintain the copper contamination in the solder to under 0.2%.

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Topic 3: Cost Justifying a Capital Equipment Purchase

Thanks to Keith Zellmer of Z-Axis

Z-Axis, Argus' sales representative in the San Francisco area and Northwest, provides assistance to its customers by providing them with critical information about how the product or service will meet their needs and expectations. In its client newsletter, The Inside Trac, Z-Axis discusses the following points required in a well-prepared **Justification Report**:

GOAL - The first paragraph of the proposal should contain a brief executive summary of the goal for a project. This will contain the information necessary to tie this project to the overall business or technical plan for your company.

PROBLEM - A brief description of the problem facing the company. You should include the primary reasons for initiating this project. Capacity, efficiency, capability, and safety are quantifiable in payback calculations. Another measurable reason is the cost to maintain an aging system's performance. How to place value on these reasons will be discussed briefly in the Payback section to follow.

SOLUTION - This section should deal with the ways that your purchase proposal addresses the problem described above. You may want to include technical information as attachments to support your conclusions.

ALTERNATIVE ANALYSIS - In any choice, there is always more than one way to solve the problem at hand. In fact, our economy evolves and improves based on the creativity we can apply to industry-wide technology issues. As you selected the system or service of choice, you no doubt compared competitive information and costs to determine the best fit for your company. These points should be discussed here to support your choice, and explain the benefits of your selection (which may not be the lowest cost option). If any references were called on to verify performance of a system or service, this is a good place to include them to further support the conclusion you reached on the purchase.

PAYBACK - Payback in months = Cost divided by additional PROFIT per month. A purchase must be paid for before the company can show additional profits from the improvement. Naturally, the shorter the time to payback the investment, the more attractive the investment will be to the owners of the company.

CAPACITY - is valued by the additional revenue the improvement can generate. Be sure to assess only the additional PROFIT to be gained through this purchase. If capacity requires an additional operator, materials or utilities, those costs must be subtracted from the gross gain to assess the real improvement for the company.

EFFICIENCY - is also valued based on the PROFIT gain resulting from the proposed improvement. Efficiency is shown by reducing cost through elimination of inventory, personnel, materials, tools, and waste products; or, reduction in cycle time to produce the product to be sold. Be careful not to confuse efficiency with capacity. It is not beneficial to improve the output of a production process unless it is a constraint to the company. It is ALWAYS beneficial to improve the efficiency of a process.

CAPABILITY - is measured in the ability of the company to meet the changing needs of its customers, or increase production yield.

YIELD - is a powerful payback tool since it eliminates waste and reduces cost of goods sold across the entire company. It can be calculated as a straight percentage of all process costs up to the point of yield increase, and returned as pure PROFIT to the company.

MAINTENANCE COSTS - are simply the costs per year in parts and labor to maintain aging process performance. If the cost to maintain the process or equipment exceeds the depreciation of a new system purchase (plus the maintenance costs projected for the new system), the reduced cost is returned to the company as PROFIT.

SAFETY - in the workplace is extremely important to the owners of a business since the workers ARE the company. The elimination of an extreme safety hazard is often all the justification needed to gain approval. Research should include the costs of insurance, workmen's compensation claims, and in some cases, fines assessed through OSHA. These reductions can then be turned back to the company as PROFIT.

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