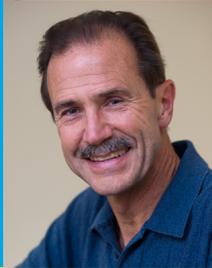




Expertise, technology, and gases:
A total solution for the global electronics
packaging, assembly and test industry



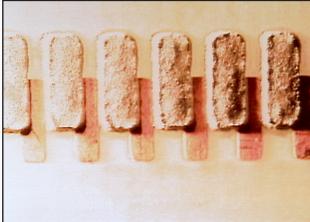
“Our objective is simple—we use our 20+ years of global experience to deliver the expertise, technology and gases to help you improve your productivity and optimize your total cost of ownership.”



Constantly evolving to meet your needs

Self-alignment, lead-free solder paste offset printing

Figure 1: Air Versus Nitrogen Reflow



Offset printing of solder paste on printed circuit board pads.



Reflowed in air atmosphere, poor wetting and high concentration of flux residue.



Reflowed in nitrogen atmosphere, excellent wetting and minimal to no flux residue.

Devices with smaller spacing and increased packing densities. Lead-free solder implementation with finer powder sizes. No-clean flux chemistries. In the electronics assembly and packaging industry, you are constantly adjusting to something new. At Air Products, we are with you every step of the way to help you achieve greater productivity with fewer defects. Our expertise, technologies and gas supply advantages can provide improved cost reductions, uptime, defect reduction, and an overall improvement in the total cost of ownership for your integrated circuit (IC) packaging and printed circuit (PC) board assembly processes.

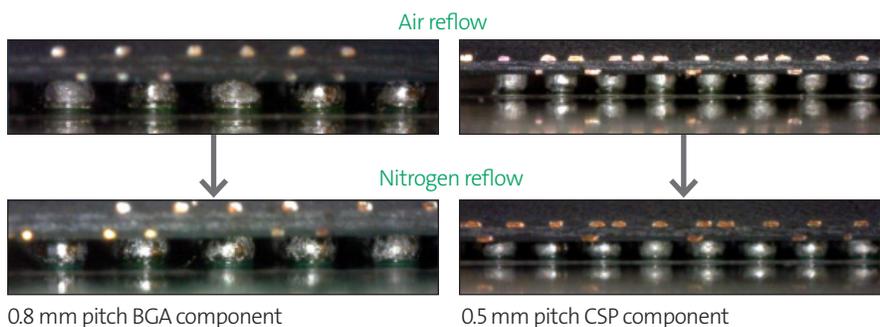
We have a dedicated team of application engineers providing local and regional support to customers throughout the world. Our global Electronics Packaging, Assembly and Test Team's breadth of experience, understanding of evolving customer needs, and shared best practices bring key advantages to your business. This multitasking team offers diverse capabilities and is constantly evaluating programs, including: developing gas and process technology such as fluxless soldering and understanding the effects of atmosphere composition, and then bringing these developments commercially to our customers; providing technical support, including problem resolution, process optimization, and cost reduction programs; conducting industry-relevant R&D activities with joint development projects with customers, such as lead-free soldering, production trials, and cost of ownership programs.

Nitrogen reflow for head-in-pillow defect reduction

In a study conducted by Air Products, the reflow process of BGA and CSP components under a nitrogen (reduced oxygen) environment while using a low activity resin-based paste demonstrated better wetting performance than under an air reflow environment.

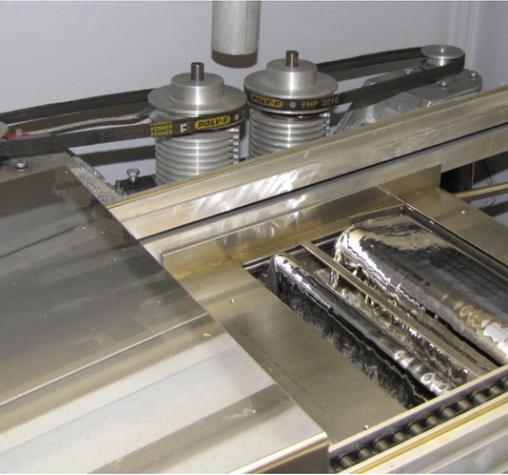
Nitrogen reflow prevented the formation of new oxides, while avoiding the use of solder pastes with high fluxing capacity, providing improved wetting performance, fewer HIP defects, and improved quality and cleanliness of the solder joints, as compared to a conventional air reflow process. (Figure 2)

Figure 2: Reduced Head-In-Pillow (HIP) Defects Upon Nitrogen Reflow



These comparative photos show the effectiveness of reflowing a 0.8 mm pitch BGA component, left, and a 0.5 mm pitch CSP component under nitrogen vs. air. Reflowing under nitrogen resulted in faster formation of cleaner solder joints with few, if any, HIP defects.

Technologies that enable your success



At Air Products, we are focused on being the total solutions supplier to the global electronics assembly and packaging industry. Innovative solutions from Air Products include:

Inert wave soldering technology

Our optimized retrofit inerting technology addresses the major issues faced by the assembly and packaging industry by providing nitrogen inerting in wave soldering applications. (Table 1)

Inert reflow soldering technology

The global applications team can provide inerting trials, audits and optimization studies to improve on your reflow processes in the areas of reduced solder joint defects, increased productivity and overall cost savings through optimized gas usage.

One of our latest offerings in this area is an oxygen monitoring/nitrogen control system.

- This system is a compact unit for monitoring the oxygen level and automatically control nitrogen flow for inerting processes such as reflow soldering.
- The system automatically increases nitrogen flow when actual PPM level is above set point to minimize purge time. It also decreases nitrogen flow when the PPM level is below set point to minimize nitrogen consumption.

Table 1: Savings Per One Wave Solder Line

Item	Reduction Rate	Savings/day (NTD)/(USD)	Cost of Inerting System (NTD)/(USD)	Savings/Month (NTD)/(USD)
Dross	53%	2,100/70		46,200/1,540
Cleaning hours	60%	375/12.50		8,250/275
Flux	10%	50/1.67		1,100/36.67
Bridging	25%	N/A		N/A
Sub-total				55,500/1,850
Monthly Costs			9,750/325	
Total Savings/Month				45,800/1,523

Activated hydrogen for flux-free metal oxide reduction

- A novel, proprietary technology based on activation of hydrogen for flux-free wafer bump reflow and copper oxide reduction.
- This unique and environmentally friendly technology works at ambient pressure and low temperatures by using nonflammable concentrations of hydrogen.
- This technology will promote solder alloy oxide reduction at the melting point or slightly above it.
- Eliminates the use of fluxes and the high cost of post reflow cleaning.

Electron attachment technology

A novel, proprietary technology based on electron attachment for fluxless wafer bumping and copper oxide reduction, this unique and environmentally friendly technology works at ambient pressure and low temperatures by using nonflammable concentrations of hydrogen. The electron attachment technology promotes the dissociation of hydrogen molecules into electrically charged species to allow for the reduction of solder alloy oxides at lower temperatures than conventional flux based solder alloy oxide reduction processing. This technology will promote solder alloy oxide reduction at the melting point or slightly above it.



Air Products has two Advanced Technology Centers for electronics assembly research and development in the United States and Asia.

Your progress partner

By partnering with our dedicated applications team for electronics assembly processes, you gain access to this broad range of established and leading-edge application technologies. We support customers in diverse applications and technologies such as: ceramic metallization; plasma cleaning of IC packaging assemblies; flat-panel displays (IC assembly); fiber optics; thermal and environmental cycle testing; glass-to-metal sealing; lead-free soldering processes; plasma desmear and etchback; fluxless soldering technologies; dry-box inerting; flip chip technology and processing; and chip-scale packaging and assembly. Optimization audits assist our customers in lower cost ownership and productivity enhancements.

Backed by the technical and research staff at Air Products' Advanced Technology Centers, our global applications team investigates current technologies in conjunction with the future assembly and packaging processes that are being developed to accommodate the new generation of integrated circuits. Through these efforts, we are able to combine the latest technological developments with hands-on process knowledge to improve customer operations, using our labs to aid you in troubleshooting and sample analysis.

Benefits of nitrogen inerting

For reflow soldering

- Elimination of metal surface oxidation
- Improved wetting of solder to component leads and board
- Reduction in overall soldering defects
- Compatible with low residue flux solder pastes
- First pass soldering yields improvements
- Labor cost reduction
- Easier post-soldering cleaning (when required)
- Wider process window

For wave soldering

- Reduced oxygen in soldering atmosphere
- Improved solder wetting
 - Increased wetting force and decreased wetting time for improved plated through hole fill
- Reduction of flux volume per board by utilization of less active flux chemistry
- Dramatic reduction in dross formation = less cleaning
 - Reduced equipment maintenance = reduced costs
 - Lead-free solder is 2 to 4 times higher in cost than lead-based solder
- No-clean process can be implemented
- Solder ball formation minimization
- Wider process window/increased uptime
- Defect reduction

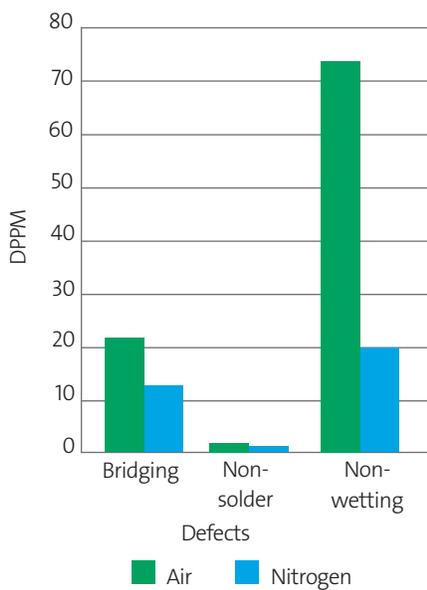
Working together

Looking to improve your process? Utilizing knowledge applied at our worldwide customer base, Air Products' global team conducts on-site audits to evaluate your manufacturing process and address your concerns. The site audit can provide realistic process cost savings and improvements, including recommendations for improving uptime, achieving higher productivity, and lowering manufacturing costs, as well as process enhancements that can be achieved utilizing atmospheric gases.

See the next page for two summaries of audits we performed at customers' facilities for "real world" examples of improved productivity and reduced defects.



Figure 3: Defects Parts Per Million (DPPM) Trend Chart-Nitrogen and Air Audit



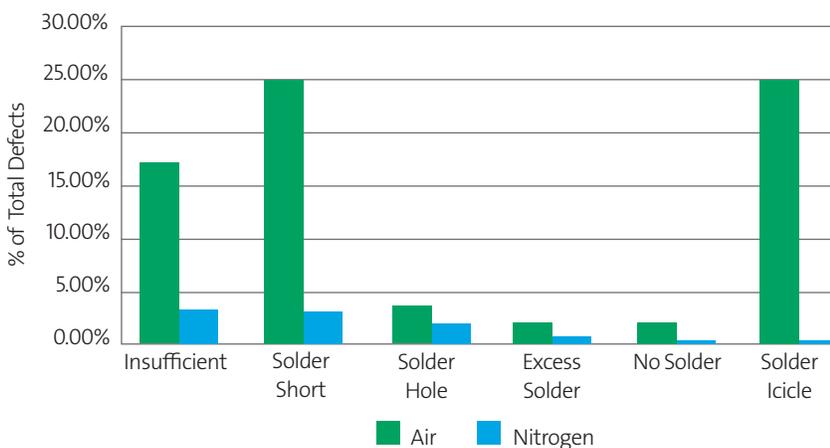
Real world process audit

Experiencing non-wetting, non-solders and bridging defects with SMT production lines, a large electronics manufacturing company brought in Air Products to evaluate their reflow assembly process. Utilizing a temporary nitrogen supply system to the reflow furnace, Air Products’ application engineers optimized the nitrogen to customer-specified oxygen ppm levels with a production run for one month. Through the evaluation, the customer’s quality inspection report found that the use of nitrogen improved their defect levels by 56% with better solder joints, good wetting appearance, reduced oxidation of component leads and a reduction in the AOI fault list. The company found the results to be so beneficial that they now utilize Air Products’ nitrogen and process technology in their SMT production lines. (Figure 3)

Real world technology audit

A large contract assembly house turned to Air Products to achieve lower defects, and in turn, a reduction in solder dross for their wave solder processing lines. The assembly company’s primary concern was several major solder defects that were very difficult to repair and required costly manual rework. An investigation was conducted utilizing Air Products’ proprietary inert wave soldering retrofit technology to introduce nitrogen into the wave solder process. The test program was run for one month with a defect reduction of 90%. During review of the program, the assembly house found the inert wave soldering technology had reduced dross formation and solder oxide by 96% in day-on-day production rates. While not the primary goal of this evaluation, the dross reduction, and hence the significant reduction in the amount of virgin solder required, provided the company with an annual savings per wave solder line of US \$35,000. This added benefit was able to provide more production uptime and a reduction in material costs. (Figure 4)

Figure 4: Technology Reduces Defects and Dross



Air Products’ inert wave soldering technology helps an electronics contract assembly company reduce wave solder defects by 90%. Dross formation was reduced by 96% in day-on-day production rates for an annual savings per wave solder line of US \$35,000.

The right gas supply solution



To complement our technologies, we offer the complete portfolio of reliable and safe gas supply options from liquid/bulk gases to a host of on-site production technologies. Whatever your purity requirements, volumes, and usage needs, we can deliver the right gas supply to meet your exacting process requirements day in and day out.

Liquid/bulk delivered gases

Whether your application requires nitrogen, oxygen, hydrogen, argon, helium or a blend of gases, you'll benefit from our proven experience supplying bulk gases to the electronics industry. Stored in tanks at your site and vaporized as needed for your process, our in-house fleet of computer-dispatched tankers and our trained drivers enable us to quickly fulfill your gas supply requirements.

On-site generated gases



Air Products offers a full line of on-site nitrogen generation systems which provide significant savings compared to traditional supply methods. Our High Purity Nitrogen (HPN) plants provide cryogenic-purity nitrogen at 300 to 4,000 normal meters³/hour and at a substantial savings compared to hauled-in

liquid nitrogen. These HPN plants feature a compact design and easy installation, giving you a dedicated production facility with backup supply. For other processes and applications, our PRISM® PSA or membrane noncryogenic systems can provide on-site generated nitrogen with potential cost savings of up to 50 percent compared to traditional supply modes.



Safety is key

For us, safety is just the proper way to do business. We continually enhance and update our safety capabilities, and our safety services are available for everything from employee training on the safe use of our gases at your site to a complete review of your total atmosphere system from delivery to the point-of-use.

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This brochure provides just an overview of our capabilities for the electronics packaging and assembly industry. For additional information, please visit our website or contact:

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