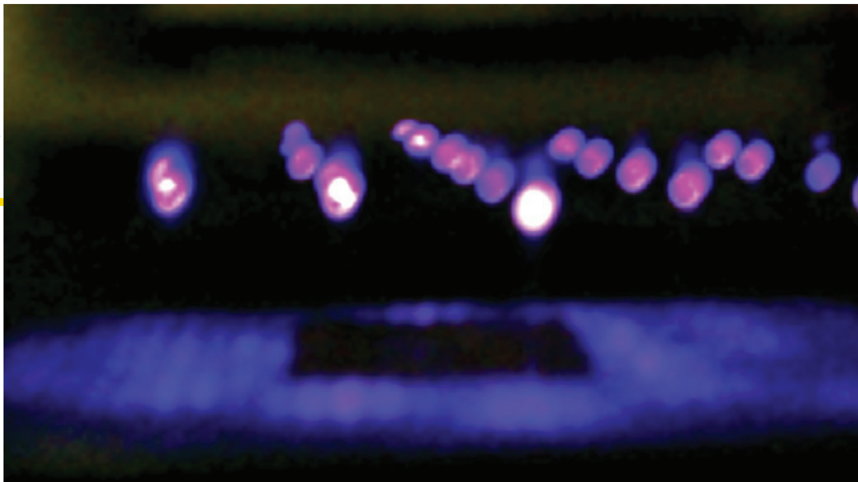
Fluxless soldering using electronic attachment (EA) technology

AIR PRODUCTS

Proprietary, patented innovation for standard electronics assembly and packaging processes



Building on our 25 years of proprietary and patented innovation for the global electronics packaging industry, Air Products introduces breakthrough technology that uses electron attachment or EA to activate hydrogen at ambient pressure and at a starting temperature as low as 100°C.

A new breakthrough technology

EA can be built into standard assembly and packaging processes and has the potential to be applied to applications ranging from wafer, die and chip levels to the traditional PC board assembly. By working with our partners and customers, Air Products is actively working towards bringing EA technology to commercialization.

What is electron attachment?

Our studies suggest that the EA process (see Fig. 1) promotes the formation of atomic hydrogen anions, a strong reducing agent that removes surface oxides on solder and base metals. Driven by electrical fields within the EA process, these atomic hydrogen anions move directly toward the soldering surface, making it possible to use hydrogen concentrations as low as a nonflammable range of 4 percent.

EA enables a variety of commonly used solder alloys in electronic assembly processes to reflow and wet at temperatures a few degrees above their melting points. Major benefits can include a large increase in the process-operating window, a complete elimination of flux residues, and a significant reduction of voiding tendency in solder joints.

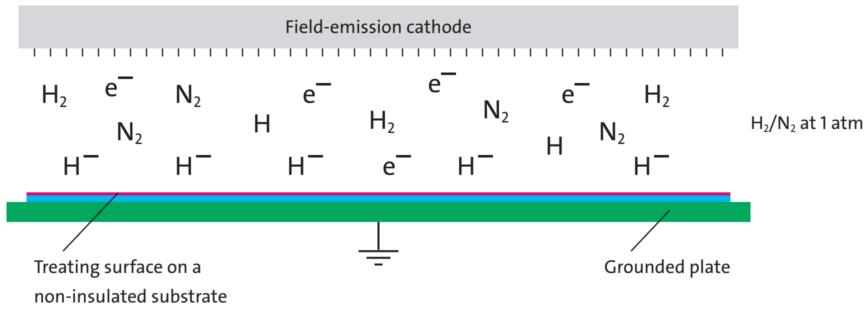
EA has several advantages for key applications.

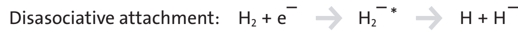
Wafer bumping

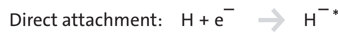
Wafer bumping is a critical step in wafer-level packaging. A reflow process is used to form homogeneous solder spheres on the wafer surface. The prevention of solder oxides during reflow is essential for bump shape uniformity and formation of strong metallic interconnect phases.

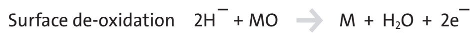
During the reflow heating cycle, an electron emission device is turned on to establish an EA environment surrounding the solder bumps.

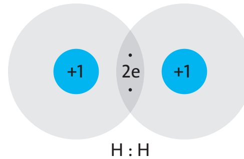
Figure 1. The basic principle of electron attachment











EA pre-cleaning resulted in a much-improved solder wetting when compared to no EA.

When compared with a flux-based process, EA also showed a significant advantage on solder wetting (see Fig. 2). In addition, the EA process can also help to reduce flux residue induced de-lamination and corrosion problems.

And, because of the improved solder wetting and the elimination of flux, voids are largely minimized (see Fig. 3).

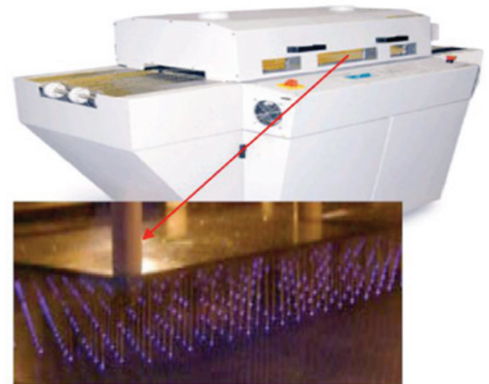
Solder bumps reflowed (see photos below) under EA have a very smooth surface and spherical shape, driven by a high surface tension of the oxide-free molten solder. In the absence of electron attachment, the solder bump surfaces are quite wrinkled, and the bump height is small due to the restriction of the oxide skin on the molten solder during reflow.

Die attach

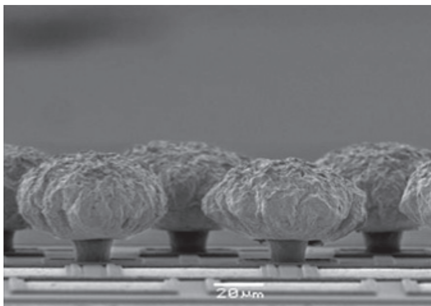
Die attach is a process during which an individual die containing an IC is bonded onto a substrate. A high-quality die attach with low voids, no de-lamination, or corrosive residues, is important to achieve good thermal/electrical properties and to minimize stress-induced failures during device operation.

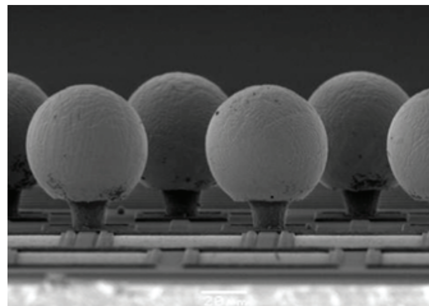
A die attach assembly is set on a specially made ceramic plate. EA is applied to clean oxides and contaminants from the metal surfaces to be jointed.

The use of EA has allowed significant reduction in the peak reflow temperature for the subsequent bond formation step, minimizing temperature induced die damage. Due to efficient oxide removal,



During the reflow heating cycle, an electron emission device like this is turned on to establish an EA environment surrounding the solder bumps.





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Continuous and PCB reflow

Reflow soldering is a common method of attaching surface mount components to a circuit board. This is typically done in a convection reflow furnace.

Our future developmental activities in the area of EA technology for reflow soldering can help to solve two major current challenges:

- Increased difficulty in flux residual cleaning due to device miniaturization.
- The narrow reflow process window and potential non-uniformity heating on mass diverse components.

The many benefits of EA technology

EA technology offers several potential benefits for productivity, quality and cost of ownership.

EA can improve productivity by:

- Being in-line process capable.
- Eliminating flux residue cleaning.
- Requiring no maintenance for flux vapor contamination.

EA can improve product quality by:

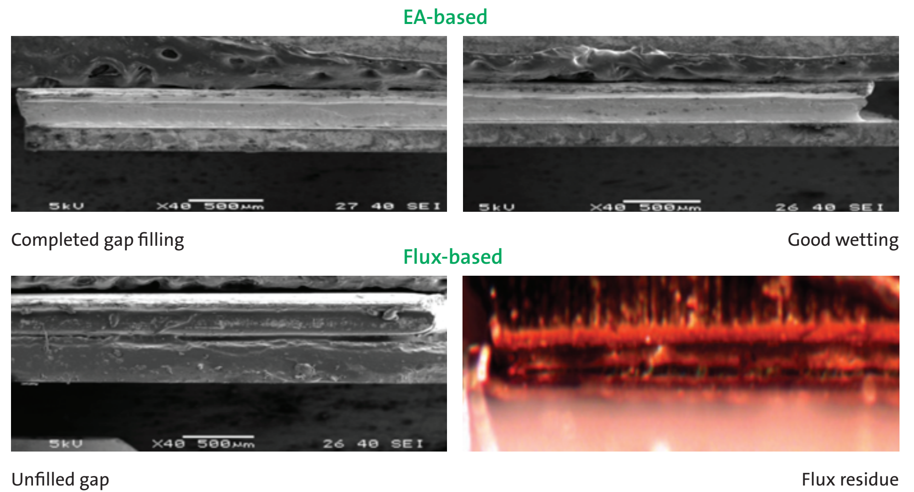
- Reducing defects by widening the process-operating window.
- Creating less voids and higher bonding strength for die attach assemblies.
- Being completely free of corrosive flux residues.
- Enabling a low process temperature.

Finally, EA can lower your cost of ownership by:

- Eliminating costs from pre- and post-cleaning steps.
- Reducing costs due to rework.
- Reducing the footprint of equipment.

Figure 2. Oxide removal and solder wetting

Comparing EA-based and flux-based solder wetting



Completed gap filling

Good wetting

Unfilled gap

Flux residue

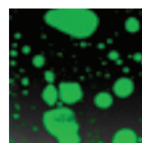
EA-based approach resulted in an even better wetting than that of flux-based soldering. Flux residues were left between layers for flux-based solder wetting.

Figure 3. Void reduction

Void formation under ambient pressure with fux vs. EA

Voids formed for all the flux soldered dies.

With using flux, voids were formed for all dies, and 24% voids were found for 2mm x 2mm die. By applying EA pre-cleaning, zero voids was achieved for 2mm x 2mm die.



24% voids for 2mm x 2mm die with flux.

0% voids for 2mm x 2mm die with EA.

Contact us today

We welcome the opportunity to show you how our latest breakthrough electron attachment technology can benefit your electronics packaging application. Please call 800-654-4567 or visit our website.

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