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CASE STUDY

Optimizing Die Attach for Surgical LED Devices with Non-Cytotoxic Silver Epoxy

How the combined expertise of fluid dispensing leader *Nordson EFD* and specialty adhesive manufacturer *Master Bond* ensured an optimal manufacturing process

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Case Study: Optimizing Die Attach for Surgical LED Devices with Non-Cytotoxic Silver Epoxy

Introduction

Dispensing a highly viscous, silver-filled epoxy onto a surgical LED device presents a nuanced engineering challenge: how to achieve precise, repeatable deposits without introducing voids, or compromising thermal and electrical performance.

A medical device manufacturer faced this exact problem when developing a die attach solution with stringent electrical, thermal, and biocompatibility requirements. In addition to delivering conductivity and heat dissipation, the material needed to maintain precise deposit geometry, cure at 125°C or below, and support a repeatable, automated dispensing process.

This application required close alignment between material properties and dispensing technology. The epoxy had to meet performance and regulatory standards, while the dispensing system needed to produce consistent, defect-free deposits without tailing, clogging, or air entrapment.

The resulting solution delivered highly repeatable dispensing, minimized process variation, and enabled reliable thermal management as well as electrical performance in production.

Application Requirements

The die attach adhesive needed to:

- Create and maintain electrical contact between the LED die and substrate
- Conduct heat away from the die to preserve LED output and service life
- Retain a thixotropic, paste-like shape without bleed-out onto adjacent pads
- Cure at or below 125°C to avoid damage to the LED
- Pass ISO 10993-5 for non-cytotoxicity
- Support repeatable, automated dispensing

Product Solution: Master Bond EP3HTSDA-2Med

EP3HTSDA-2Med is a one-component, silver-filled epoxy that passes ISO 10993-5 specifications. Other properties include:

- Volume resistivity: < 0.001 ohm-cm
- Thermal conductivity: 6.5–7.0 W/(m·K)
- Silver particle size: 2–3 µm average (≤25 µm maximum)

These properties enable thin bond lines and low thermal resistance for efficient heat transfer, which is critical for maintaining LED performance and reliability.

The Master Bond EP3HTSDA-2Med silver filled epoxy was the ideal solution for automated die attach dispensing.

Because the epoxy is not premixed or frozen:

- No mixing or freezer storage is required; standard refrigeration is recommended
- Working life at room temperature is effectively unlimited
- Cure is activated only by heat (125°C for 1 hour) in a forced air convection oven

The material's thixotropic nature allowed it to hold its shape after deposition, resist migration, and maintain a consistent die attach pattern.

Key features include:

- ISO 10993-5 rated for non-cytotoxicity
- Silver-filled with high electrical and thermal conductivity
- One-component, heat-cured, with an "unlimited" working life at room temperature
- Thixotropic paste viscosity ideal for automated die attach dispensing

Dispensing Solution

After laboratory evaluation, the following silver epoxy dispensing system was selected:

- 3-axis PRO4 tabletop robot
- UltimusPlus I dispenser
- 3cc syringe barrel
- 20-gauge rigid tapered tip

This combination provided the best balance of accuracy, repeatability, and process control.

The Nordson EFD fluid dispense solution for the application included a 3-axis PRO4 tabletop robot, an UltimusPlus I dispenser, a 3cc syringe barrel, and a 20-gauge rigid tapered tip.

Automation and Dispensing Technology

A PRO4 robot with custom fixturing was selected to ensure stable and accurate placement.

Key capabilities:

- CCD smart vision system for precise alignment
- Repeatability of ±0.003 mm
- Laser height sensing to compensate for substrate variation

These features ensured consistent, accurate deposit placement across multiple dispense points on a tight tolerance substrate.

UltimusPlus I Dispenser Selection

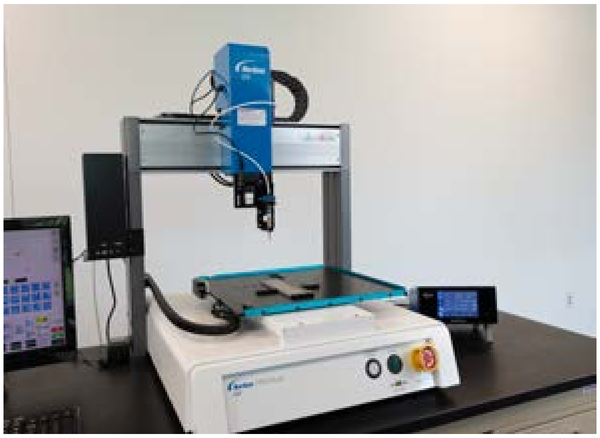
The UltimusPlus I air-powered dispenser was selected for precision fluid control, but also for material compatibility.

The EP3HTSDA-2Med epoxy contains fine silver fillers critical to conductivity. In mechanical valve systems, shear forces can damage these particles, degrading performance.

The UltimusPlus system avoids this by:

- Minimizing shear during dispensing
- Preserving filler integrity
- Maintaining consistent electrical and thermal performance

This made it a superior choice over mechanical valve-based systems.



The engineering team selected the 3-axis PRO4 automation system and UltimusPlus I dispenser because it delivered the consistent, precise process control necessary for the application.

Additional benefits include:

- PLC integration via Ethernet (NX protocol via TCP/IP)
- Built-in dispense logging for traceability
- Remote programming and monitoring
- Reduced air consumption via Sleep Mode

Syringe Barrel and Tip Selection

The EP3HTSDA-2Med epoxy was supplied by Master Bond in pre-filled 3cc Nordson EFD syringe barrels, eliminating transfer steps and reducing contamination risk.

Barrel advantages include:

- Chemical compatibility
- Dimensional consistency
- High clarity

Tip Selection

A 20-gauge rigid tapered tip was selected for optimal flow control and a smooth, consistent dispense rate.

Compared to general-purpose tips, tapered tips:

- Reduce flow restriction and backpressure
- Improve consistency for high-viscosity materials
- Enable faster, more stable dispensing

The 20-gauge rigid tapered tip was selected to manage backpressure issues, and reduce flow restriction during dispensing.

Dispensing Challenges and Backpressure Management

Although the application required small deposits, the material's properties introduced complexity:

- Viscosity > 400,000 cps at room temperature
- Thixotropic index of 6.75

Limitations of General Purpose Tips

When dispensing high-viscosity fluids, standard tips create high backpressure due to narrow flow paths, leading to:

- Inconsistent deposits
- Over-dispensing
- Potential material separation

Advantages of Syringe Dispensing

The syringe barrel and tapered tip were selected because this combination met requirements for a small deposit size while managing the fluid viscosity and thixotropic nature of the Master Bond EP3HTSDA-2Med material. Also, this epoxy is easily dispensed at room temperature as it has an "unlimited" working life. Therefore, using a syringe instead of a valve made the syringe change out process simple and easy, saving time thus increasing productivity.

The 3cc syringe size of the Master Bond EP3HTSDA-2Med material eliminated any issues associated with the full to empty effect. The small cylinder size with the tapered tip helped ensure accurate, and repeatable deposits on the die attach component.

The combination of Master Bond's EP3HTSDA-2Med epoxy and Nordson EFD's precision dispensing system delivered a robust, repeatable process for manufacturing this critical surgical LED die attach component.

Material Packaging and Air Control

Master Bond supplied the epoxy as a true one-component system, eliminating freezing and mixing requirements.

To prevent air entrapment:

- The material was degassed prior to filling
- Syringes were filled under controlled conditions
- Direct filling eliminated transfer steps

This is critical because voids can cause:

- Thermal hotspots
- Electrical discontinuities
- Reduced mechanical strength

Conclusion

The combination of Master Bond's EP3HTSDA-2Med epoxy and Nordson EFD's precision dispensing system delivered a robust, repeatable solution for this surgical LED die attach application.

The epoxy met all key requirements, including electrical conductivity, thermal performance, curing constraints and biocompatibility, while its rheology enabled stable, and repeatable deposition. The dispensing system ensured precise placement, consistent flow, and process control across multiple dispense points.

Equally important, the air-powered dispensing approach preserved the integrity of the silver filler, avoiding shear-related degradation seen in mechanical systems and ensuring reliable post-cure performance.

Have a dispensing question you'd like us to answer?
Don't hesitate to submit your question or comment at info@nordsonefd.com

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Cross-referenced with https://www.nordson.com/en/About-Us/Nordson-Blog/EFD-Blogs/Optimizing-Die-Attach-for-Surgical-LED-Devices-with-Non-Cytotoxic-Silver-Epoxy

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Rohit Ramnath is a Senior Product Engineer with over 12 years of experience at Master Bond where he manages new product development right from concept development to procurement to product launch via numerous marketing channels such as news releases, and case studies. He troubleshoots customer adhesive application challenges in the medical, aerospace, electronics, optical, OEM, and oil & gas industries. He co-authored 'Breakthrough instruments and products: Biocompatible epoxies for medical device manufacturing'. He received a master's degree in chemical engineering from Carnegie Mellon University in 2011. He is a CFA Charterholder®, and has a Certificate in ESG (Environmental, Social, & Governance) Investing by the CFA Institute.