New Uses of Adhesives in Durable Medical Diagnostic Equipment

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Adhesive films and tapes provide design engineers with greater freedom by eliminating the worries of joining different/dissimilar materials.

Design engineers for medical diagnostic equipment are acutely aware of the dramatic growth and change in the healthcare industry. Medical OEMs and contract manufacturers are looking for suppliers who can help them meet new industry and federal regulations, achieve the highest quality products, support new care approaches (including patient-controlled monitoring and treatment), and drive down manufacturing costs.

In many cases, design engineers are looking to replace mechanical fastening with adhesives, especially as medical devices and equipment become smaller and more complex. These types of changes in medical diagnostic equipment have affected a broad range of products, including:

- Ultrasound equipment
- Mammography equipment
- CT scanners
- MRI scanners
- Bone densitometers
- PET/CT scanners
- X-ray equipment

- Nuclear medicine scanners
- Blood monitoring equipment

The Benefits of Adhesives
As the electronics in diagnostic equipment grow more complex and the device footprint more compact, mechanical fastening can limit size reduction. In addition, mechanical fastening can prohibit design engineers from achieving the smooth surfaces and sleek aesthetic appeal they are seeking. Adhesives, on the other hand, provide many benefits:

- High strength, durable bonds—In many cases, adhesive bonds are preferable due to their ability to be rigid, flexible, or load dissipative, and to meet high-use, repetitive demands.
- Invisible joints—By eliminating screws, rivets, and welds, the medical product not only looks better, it also weighs less, and can be easier to clean.
- Stress, fatigue relief—Adhesives distribute stress evenly across the bond line, eliminating stress fractures in plastics, composites, and other materials. The viscoelasticity of adhesives allows bond lines to resist fatigue, as well as shock and vibration. This results in quieter operation and a longer lasting unit.
- More material options—Adhesives provide design engineers with greater freedom by eliminating the worries of joining different/dissimilar materials.
- Air and water-tight seals—Perfect for equipment used in harsh environments or subject to sterilization, adhesives can extend work life and improve quality and durability.

Picking the right adhesive reduces manufacturing cost through reduction in materials, weight, and the time spent drilling, screwing, and welding parts together.

Adhesives for Diagnostic Equipment
The primary types of adhesives used in diagnostic device applications include:

- Epoxies
- Acrylics
- Cyanoacrylates
- Urethanes
- Acrylic pressure-sensitive adhesive (PSA) tapes
- Adhesive transfer tapes

These adhesives may be certified to comply with ISO 10993 or are USP Class VI approved. They may also be formulated for biocompatibility and sterilization, as required.

Epoxies
Epoxies are used extensively as liquids and as films that can be die-cut to intricate custom shapes. Epoxy bonding systems are a good choice when the bond line geometry presents a gap that must be filled. Epoxies are well-suited for rigid

structural bonds and are available in formulations for:

- Instant bonding epoxy for most plastics, rubbers, and metals, including low surface energy (LSE) plastics
- UV cured structural epoxy for bonding glass, most plastics, and metals with high temperature resistance
- Structural adhesives for metal, plastics, and rubber with durable adhesion, flexibility, heat resistance, and void-filling

Epoxy-based adhesives are often used for joining surfaces in medical devices and equipment. They are excellent adhesives for these application due to their high strength, compatibility with many materials, and chemical and moisture resistance. In addition, several epoxy formulations are non-toxic, making them suitable for medical devices where the risks of allergic reaction are important to patient safety.

Acrylics
Fast curing acrylics are available as one-part anaerobic adhesives that cure in the absence of oxygen, one-part light-cure adhesives that set up in seconds, and two-part formulations with improved viscosity and handling characteristics.

Cyanoacrylates
Cyanoacrylates (CAs) are also popular; they include one-part formulations that cure within seconds and are well-suited for joining materials that are difficult to bond, including polypropylene and polyethylene. These adhesives are ideal for joining plastics such as ABS, PVC, latex, polycarbonate, styrene, acrylic, and thermoset plastic. CAs are chemically similar to common “super glues.” Their ability to bond with low surface energy plastics makes them a favorite for design engineers looking to work with new substrates in their medical and diagnostic equipment designs.

Urethanes
Urethanes are available in one- and two-part formulations and form uniquely tough but flexible bonds. Urethane adhesives are often selected for their enhanced chemical and thermal properties. This makes urethanes suitable for reusable equipment that must undergo repeated sterilization. Urethanes are not suitable for high moisture environments.

Acrylic Tapes
Acrylic and acrylic foam tapes bond on contact with no fixturing, and absorb shock and vibration. They are a good replacement for rivets and screws for invisible fastening to permanently bond many materials, seamlessly, whether they are flat or curved. Design engineers love acrylic tapes because these pressure-sensitive adhesives can be die-cut to any size or complex shape.

Adhesive Transfer Tapes
Adhesive transfer tapes are PSAs backed with a release liner. Available in rolls for easy handling, these tapes require no drying time or adhesive clean-up. They are a good choice for attaching faceplates, nameplates, or panels to LSE substrates and powder-coated, enamel paint surfaces, plasticized vinyl, or even silicone.

Selecting the best attachment method for a particular application often requires testing and consideration of the production process, whether the process will be manual or automated.

Medical Diagnostic Equipment Applications
Adhesives provide design engineers with greater latitude in every aspect of diagnostic equipment development, from electronic components to equipment faceplates and panels. Adhesive applications include:

- Electrical and electronics—Electrical insulation and conductivity, thermal management, EMI/EMC shielding
- Bonding and sealing components—Equipment panels, handheld monitors, LCDs
- Attaching components—Membrane switches, control consoles, remote controls
- Bonding sub-assemblies—Blood transducers, endoscopes, surgical and orthopedic tools (including handheld tools)
- Gasketing and sealing—Air- and water-tight connections

As diagnostic devices become smaller and more complex, EMI/RFI shielding is increasingly critical.

In electrical and electronics medical applications, insulating and conductive adhesive formulations are available, as well as thermally conductive liquids and transfer tapes that offer solutions for bonding heat sinks, heat spreaders, or other cooling devices to IC packages, power transistors, and heat generating components in medical diagnostic equipment.

Adhesives also play an ever expanding role in replacing mechanical fasteners for adhering components in medical equipment. Design engineers find adhesives useful for producing sleek, aesthetically appealing designs. In addition, adhesives can provide the smooth, contoured surfaces that are easier to keep clean in a clinical environment.

As more handheld medical diagnostic products are developed for home use, adhesives can provide an advantage in attaching membranes, displays, and other components for handheld medical devices, like blood sugar testers. In addition, optical-grade adhesive films can also be used as protective transparent materials to improve and protect display performance.

The use of adhesive and sealants is important for devices and equipment that are used in harsh environments in hospital, surgical, or clinical settings, or that undergo repeated cleaning and sterilization.

The Role of the Converter
The importance of working with an experienced converter in the medical device industry can’t be overstated, especially to take advantage of advanced adhesive capabilities. Converters deliver a range of die-cutting capabilities, advice in selecting the most appropriate materials, and the ability to identify the best adhesive for an application.

A converter can help medical OEMs or contract manufacturers from the initial design and development stages through production, assembly, and kitting. Converters have the materials and adhesive expertise to qualify materials based on:

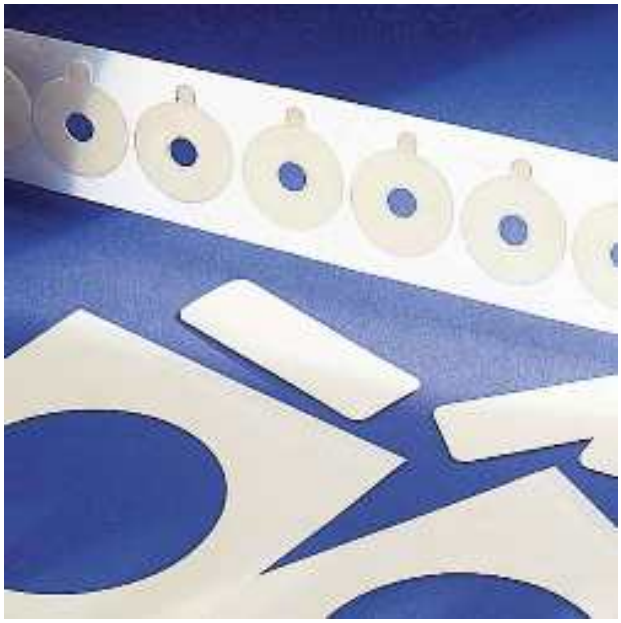
- Material performance at upper temperature limits
- Shear, tensile, and peel strength
- Electrical conductivity, dielectric strength, and outgassing
- Thermal conductivity and heat dissipation

As more medical diagnostic devices move to a handheld configuration, especially as ongoing monitoring and care responsibility is shifted from the physician/healthcare provider to the patient, and remote health monitoring becomes more popular, selecting the right material and adhesive combination becomes more important.

For example, in a handheld diagnostic device with an LCD display, a converter provides expertise in many areas of design and manufacture:

- Lens assembly, using high-performance die-cut tape for UV-coated surfaces
- Lens protection with die-cut protective tape
- LCD construction and shielding using optically-clear, die-cut polyester tape and acrylic tape to attach the LCD to the panels
- Die-cut foam gasketing with double-coated adhesive for high adhesion to

LSE plastic surfaces



Medical diagnostic components may require die-cutting, slitting, laminating, or water jet cutting to exacting tolerances.

Servo driven rotary die-cutting, CNC die-cutting, laser die-cutting, and water jet die-cutting processes can be used to meet the complex specifications of medical components. For complex foam tape die-cutting, water jet technology provides clean edges with no distortion. Laser die-cutting, kiss-cutting, slitting, and laminating can also be used in converting for medical applications.

In many instances, the converter provides label printing for tamper-evident and custom pressure-sensitive labeling of medical devices. An experienced converter can also suggest the appropriate adhesive alternatives for a specific application, such as single- or double-coated tapes, the best liner for the application, whether a foam tape is well-suited for the application, and what might be available in hydrocolloid tape formulations.

A converter’s state-of-the-art test facility with the following capabilities also helps the medical OEM to select the right materials and adhesives for the application:

- Part dimension verification
- Adhesive/release liner testing
- Material strength
- Static shear
- Material weight
- Microscopic imaging
- Electrical properties, including dielectric strength

Conclusion
Designing and manufacturing medical diagnostic devices and equipment can benefit from the use of a variety of flexible materials and adhesives. Medical OEMs and contract manufacturers rely on an experienced converter to help them select the best materials solutions to meet their application requirements and design-for-manufacturability goals.

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