4 Considerations for Overmolding Micro Medical Electronics

Understanding the opportunities of micro injection molding over delicate substrates

Customers are sometimes surprised to learn that not only is overmolding an available option, but it can often improve the functionality of their micro medical devices and implants.

Replacing a process that originally included the application of epoxy, for example, to encapsulate a delicate substrate with a more repeatable, scalable process like overmolding provides many benefits.

Benefits

1. High part precision achieved by leading-edge molding equipment, capable tooling, and robust validation procedures
2. Shot-to-shot consistency guaranteed by instrumented molds
3. Improved part functionality, such as a water-resistant or hermetic seal
4. Cost-effective high volume production achieved through robotics and automation
5. Avoidance of foreign materials such as glues and adhesives into the final medical device
6. Significant reduction or elimination of costly and cumbersome assembly operations that can lead to failure modes and high fall-out rates

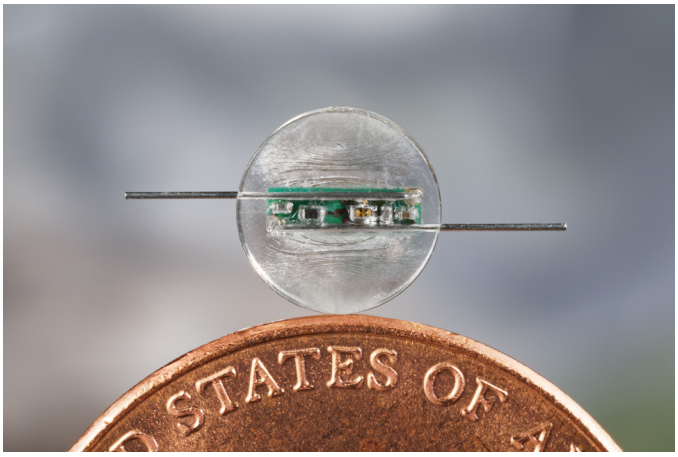

FIG. 1: This miniature medical sensor was gently overmolded with a medical-grade acrylic.

Overmolding Misconceptions

A common misconception is that the high temperatures and injection pressures required for micromolding would damage or even destroy delicate substrates like electronics. With an understanding of unique micromolding pressure and temperature phenomena, it is possible to overmold—and even encapsulate—electronics without causing damage.

PRESSURE

Contrary to many assumptions, the pressure limit of a micromolding machine is not the measurement of what pressure the substrate is seeing from the plastic. So a machine's 43,500 PSI pressure limit does not mean the substrate is being impacted by 43,500 PSI of force.

Plastics flow in layers called laminates and injection pressures don't result in hitting the substrate with direct force; instead they "roll" over it. In Figure 1 above, flow lines seen under high magnification show how gently the cavity was filled to successfully encapsulate the substrate without causing damage to the sensor.

Also, because injection is the fastest part of the entire molding cycle, the injection pressures from the injection cylinder are extremely quick.

TEMPERATURE

Temperatures can be very high in micromolding but the time that the substrate is exposed to the high temperature is very low—only a fraction of a second. It's similar to quickly passing your hand through an open flame without burning yourself.

Mold temperature is the minimum temperature a substrate will be exposed to during overmolding. The melt temperature is higher, but substrate exposure is very short.

For example, nylon (PA) has a mold temperature of 140–180°F. So if the mold temperature is 180° and melt temperature is 520°, the substrate will see temperatures in that range for a very brief period of time—a lot quicker than conventional injection molding.

If the substrate cannot withstand the 180° mold temperature, then there is a risk the substrate will not survive.

Overmolding Opportunities

ENCAPSULATION

Full encapsulation with uniform thin walls is a common request for delicate substrates like transponders and printed circuit boards (PCBs). Because the goal is to keep these miniaturized electronics as small as possible, the overmold must be as thin as possible.

Encapsulation is a two-step process. The first shot balances and centers the substrate, preventing it from being "pushed around" in the cavity. This allows for a uniform wall and ensures full encapsulation takes place in the second shot.

Common benefits of full encapsulation with overmolding include:

- protecting the substrate
- improving patient comfort during application
- providing a watertight or hermetic seal
- achieving uniformity and tighter tolerances for assembly (compared to epoxy)
- providing radio-opacity

PROTOTYPING

Before jumping into production, it's helpful to first ensure the successful overmolding of your electronic is possible. For example, MTD offers a prototyping service where a delicate substrate can be placed into a test tool and overmolded with one or more materials. Providing these samples allows you to evaluate, test, read, and ensure overmolding is a good option for your application and aids with material selection.

Substrates and Materials

SUBSTRATES

With the increase in smart medical devices, advanced tiny electronics are often being integrated into implants and devices that go into the body. These small but high-functioning components perform jobs like reading temperatures, storing information, and acting as markers inside the body for surgeons.

Examples of delicate substrates that can be candidates for overmolding and encapsulation include:

- printed circuit boards (PCB)
- pressure sensors
- cables and tubing
- glass
- ceramics
- batteries
- microfluidic chips
- delicate assemblies

MATERIALS

Common polymers for overmolding include:

- ABS
- ACETAL
- HDPE
- LCP
- PA
- PBT
- PC
- PEEK
- PEI
- PMMA
- PP
- PS
- PSU
- TPE
- TPU