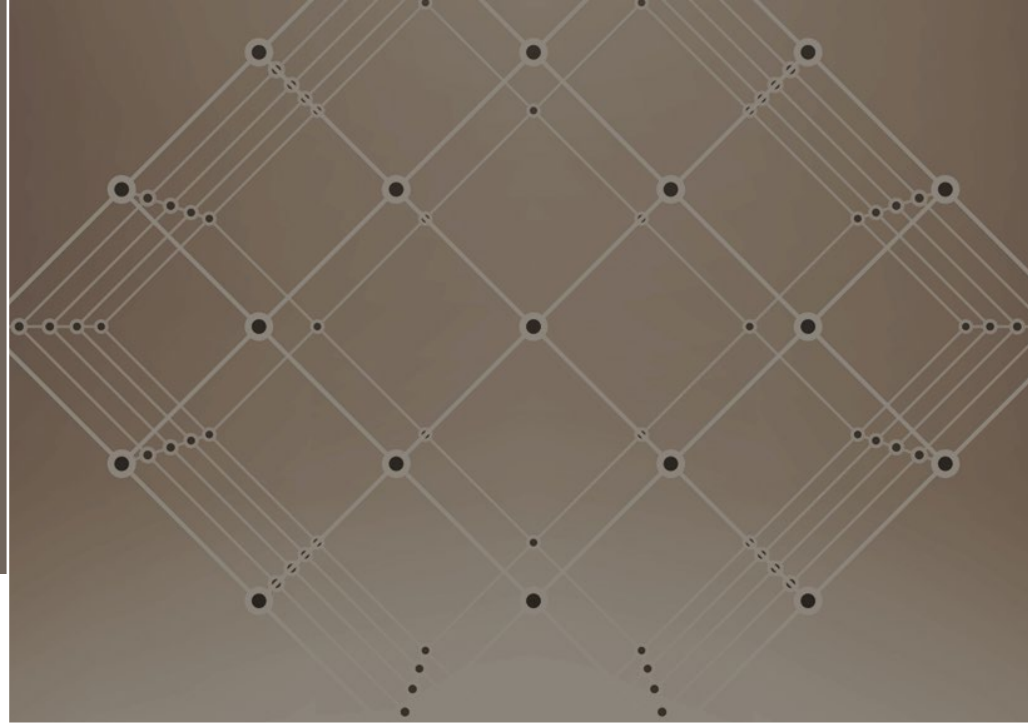

EWI®

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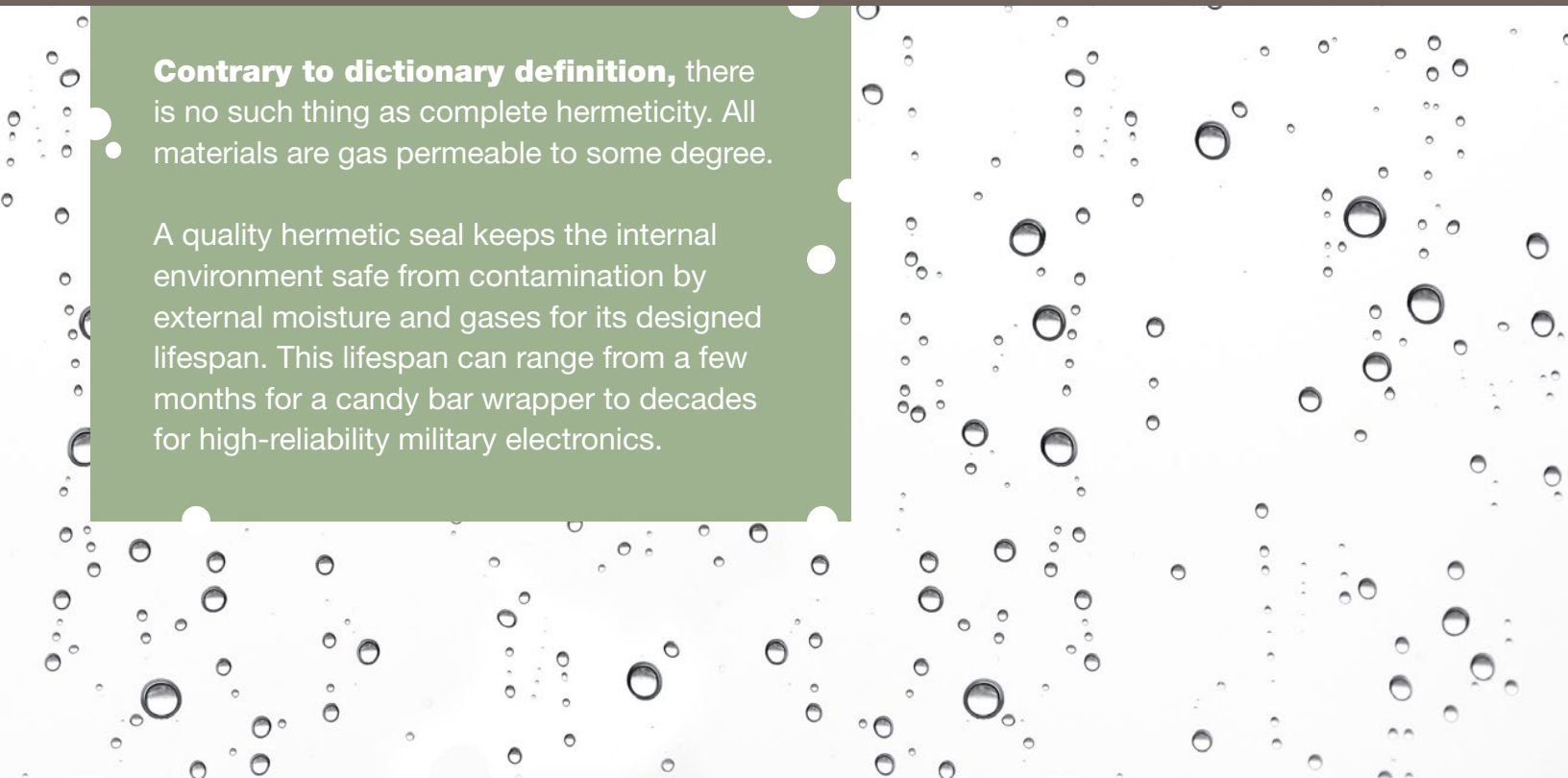
HERMETICITY

Design and Manufacturing Challenges

All Hermetic Seals Are Not Created Equal

Contrary to dictionary definition, there is no such thing as complete hermeticity. All materials are gas permeable to some degree.

A quality hermetic seal keeps the internal environment safe from contamination by external moisture and gases for its designed lifespan. This lifespan can range from a few months for a candy bar wrapper to decades for high-reliability military electronics.



Challenges of Hermetic Seals

Despite a long history of devices designed and manufactured for hermetic sealing, there remain a number of significant development challenges including:

Miniaturization
The advance of MEMS devices and physical "shrinking" of key sealing components increases the difficulty of obtaining and maintaining hermetic seals.

Outgassing of internal materials
Materials inside hermetically sealed devices may outgas causing increased internal pressures and increased stress on the seal.

CTE mismatch
Some of the common materials used for hermetic seals have widely divergent coefficients of thermal expansion, again adding increased pressure on the hermetic seal.

Biocompatibility
All implanted medical devices must pass rigorous standards for use of materials, including those desired for achieving hermeticity.

Electronic package heating
Sealed internal electronic components often generate heat, which puts increased pressure on hermetic seals.

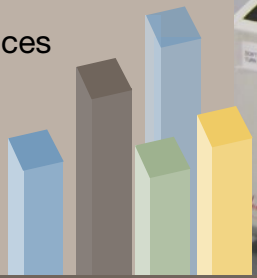
Zero-headspace
Packages, electronics completely encapsulated with potting for high reliability, leaves no space for tracer gas required for leak testing.

What Level of Hermeticity Is Needed?

The level of hermeticity or “leak-tightness” differs for each specific application.

It depends on:

- Materials choice
- Final seal design
- Fabrication processes and practices
- Use environment
- Internal package volume



Types of Hermetic Seals

Packaging uses glasses, metals, ceramics, and polymers.

MATERIALS	TYPICAL APPLICATIONS	TECHNICAL CHALLENGES
Metals	Solid oxide fuel cells, electronic packaging, MEMS devices	Dissimilar materials joining, thermal distortion, seal integrity, seal inspection
Glass-to-metal, ceramic-to-metal	Medical device feed-throughs, electronics enclosures, insulated glass panels	Robustness and life of the seal, zero leakage over time, thermal expansion mismatches, manufacturing scale-up
Ceramics	Drug delivery devices, electronic multi-chip modules	Robustness and life of the seal, dissimilar materials joining
Polymers	Pharmaceutical vials, drug delivery devices, food packaging	Integrity of the seal, consistency in manufacturing, quality inspection, chemical or environmental degradation

Determining the Level of Hermeticity

The level of hermeticity can be determined by leak rate. MIL-STD-883 TM 1014.13 is the most referenced test standard. Other tracer gases and radioactive media are also used, depending on the application.

Leakage measure is a function of both the bulk material permeation and the seal integrity.

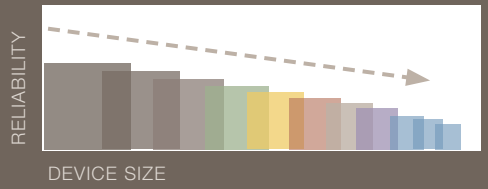
TESTING THE EFFECTIVENESS OF A SEAL

There are many accepted methods for evaluating the effectiveness of hermetic seals including:

Fine Leak	► Helium Gas
Fine Leak	► Radioactive Gas
Gross Leak	► Bubble Test
Gross Leak	► Vapor Test
Optical Leak Detection	
Ultrasonic Leak Detection	
Gross Leak using Dye Penetrant	
Gross Leak by Weight Gain Measurement	

Increased Leak Tightness for Small Devices

As devices get smaller, the reliability of hermetic seals becomes more important.

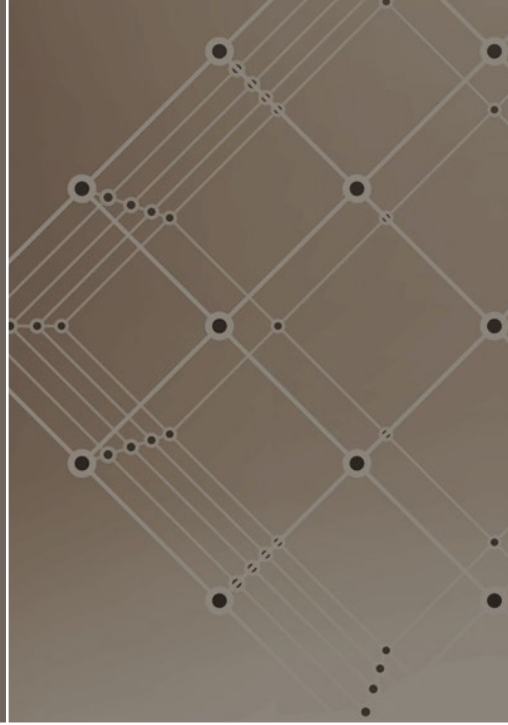


As devices get smaller, leak tightness must often increase. Smaller volumes require increased leak tightness, since a given leak rate will more significantly decrease the internal gas pressure. The loss of one cubic centimeter may not be significant for a large pressure vessel, but would be unacceptable for an implantable defibrillator.

EWI has the expertise and necessary capabilities to design devices for hermetic sealing and to develop the appropriate processes required to manufacture such devices. Our typical development process includes the following steps:

1. **Generate** concepts for joint designs that fit within the product requirements
2. **Evaluate** materials options that provide performance and life specified for the product
3. **Demonstrate** feasibility of achieving hermetic seals with selected joint configuration and materials
4. **Develop** the preliminary materials joining process
5. **Conduct** hermeticity, strength, and life tests on coupons prepared with preferred process parameters and selected materials
6. **Optimize** the joining process to define manufacturing process parameters and operating windows
7. **Design** and/or specify requirements for manufacturing equipment; select vendors or systems integrators
8. **Fabricate** prototypes in manufacturing equipment for full-scale product testing
9. **Establish** protocols and define equipment for quality inspections as required
10. **Scale-up** for manufacturing

To learn how EWI can help your company determine, qualify, and achieve the optimal hermeticity level for your product, please contact EWI at **614.688.5000.** One of our engineers would be happy to speak to you about your specific questions.



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