



## Testing EMI Materials for Battlefield Applications

Aerospace and defense technology must operate reliably in a wide variety of extreme conditions, including very high and very low temperatures and amid saltwater and harsh chemicals (from deicing fluids to missile fuel). Further, manufacturers must meet stringent requirements. As a result, the testing regimen involved in ensuring battlefield readiness is complex and multifaceted – not only for the devices that end up in soldiers’ hands, but also for the many component parts that make those devices work.

We’ve spent decades developing the materials that mitigate electromagnetic interference in aerospace and defense electronics. The testing regimen for these EMI materials has grown more complex and multifaceted in recent years, for a couple reasons:

- Electronics are getting smaller and more powerful (which results in more component parts in tighter spaces). A crowded PCB equals more complex signal challenges.
- Aerospace and defense electronics operate across a wider range of frequencies than ever before. Therefore, EMI materials must perform with precision at targeted frequency ranges (from frequencies as low as 100 MHz to frequencies as high as 95 GHz), adding another variable to the testing equation.

The testing processes for these EMI materials is crucial to battlefield performance. After all, if a microwave absorber material corrodes when exposed to saltwater, it can hinder the effectiveness of an entire communications system. Or, if an elastomer outgasses in an optical lens, it could lead to circuit failure. Given the complexity of the challenges aerospace and defense design engineers face today, testing of these component parts must cover:

- Temperature Range
- Mechanical Performance
- Fuel (and other harsh fluid) Resistance
- Frequency Range Performance

The tools and methodologies necessary to perform these tests vary. The key for aerospace and defense electronics manufacturers is to recognize the complexity of the challenges before them and embrace a holistic approach to testing. The testing of EMI materials must be rigorous and designed to predict performance over the lifetime of a material. With this comprehensive approach to testing in place, design engineers will ensure EMI materials improve the overall performance of mission-critical electronics.

## THE RUGGED ENVIRONMENT CHALLENGE



Engineers can use Highly Accelerated Stress Test chambers to test application performance in high-pressure and high-temperature environments and perform humidity resistance tests efficiently.

EMI materials can include everything from microwave absorbers to conductive elastomers to metals. These solutions operate in a variety of environments (from saltwater to low-earth orbit) and, therefore, face an almost endless list of environmental conditions that can degrade their performance. Though the list of environmental challenges is extensive, there are three big issues that rise above the rest:

- Corrosion can wreak havoc on materials, especially in naval applications. EMI materials that will be exposed to moisture must be designed to resist corrosion, and testing must prove that resilience. Further, galvanic corrosion is a concern when different types of metals come into contact as it can degrade metal interfaces and gasket performance.
- Exposure to harsh fluids such as jet and missile fuel, deicing fluid and, in some cases, the caustic solutions used to wash down vehicles that come in contact with nuclear, biological or chemical (NBC) contaminants, can degrade EMI materials. Fortunately, there are materials that can stand up to these harsh fluids. For example, fluorosilicone is resilient amid exposure to jet and missile fuel and deicing fluid. EPDM performs reliably even when exposed to the wash used to remove NBC contaminants.

- Outgassing is an especially pressing issue in aerospace applications. When a material releases a gas or vapor in an enclosure it can create films and other coverings over optics, as well as potentially cause circuit failure.



A technician prepares a piece of electronic equipment for environmental testing.

### **ADOPT A HOLISTIC APPROACH TO ENVIRONMENTAL AND MECHANICAL TESTING**

The key to testing success is, to the greatest extent possible, replicating real-world conditions in a lab environment. To ensure EMI materials can effectively operate in rugged environments (and comply with MIL-STD-802, which governs environmental performance), engineers need to complete several qualifying tests that comprehensively cover the environmental challenges EMI solutions may face.

- Standard corrosion testing can be used for almost all materials and includes the use of a salt fog chamber, which creates a warm fog atmosphere of saline solution where the material is immersed to assess how it withstands the environment.
- Fluid exposure testing consists of soaking materials in fluids and determining mass or volume swell. The standard fluid test matrix includes fuel, hydraulic fluid, lubricating oils, deicing and antifreeze fluids, and solvents and cleaners.
- Temperature testing regimens can include temperature cycling, highly accelerated stress tests, humidity testing, and more to verify performance across a wide range of temperatures.
- To ensure materials (especially metals) can withstand shock and vibration, engineers need to perform mechanical tests. For example, a fatigue analysis test can determine the lifespan of metal designs in relation to compressed heights and stress.

- Accelerated aging models help design engineers gather accurate data and better project the lifetime performance of a wide mix of materials.

## **ACCOUNT FOR EXPANSION OF FREQUENCY RANGES WITH ELECTROMAGNETIC TESTING**

As noted at the outset, the range of frequencies at which aerospace and defense electronics must operate has expanded and continues to expand, making EMI shielding more complex. From high-frequency 5G communications to low frequency radar signals to data transfer in the standard 2-18 GHz communications band, the industry needs to creatively model and implement EMI-mitigating solutions that operate with precision at specific frequency ranges. Then, engineers must validate the shielding effectiveness of those solutions.

MIL-STD-461E is the U.S. military standard that governs EMI testing and electromagnetic compatibility for military products. To meet the requirements set out by this standard, design engineers can use a variety of shielding solutions – from board-level shields to microwave absorbers to conductive elastomers – and deploy them creatively across electronic equipment that produces signal noise. Engineers should use electromagnetic modeling and simulation to determine which solutions will best address the application’s EMI challenges. Using 3D electromagnetic simulation programs, such as HFSS and Microwave CST, engineers can compare different solutions and devise an optimal layout for their EMI materials. Then, test the shielding effectiveness of these EMI materials using techniques such as transfer impedance testing and insertion-loss testing.

As aerospace and defense design engineers work to manage increasingly complex signal interference challenges across a wider range of frequencies, they must leverage all the tools available today to model and test EMI solutions to ensure electronics meet the U.S. military’s strict requirements and operate effectively.

## **DEPLOY A FULL ARSENAL OF TEST CAPABILITIES TO ENABLE ADVANCED ELECTRONICS**

With electronics getting smaller and more powerful while frequency ranges broaden, the aerospace and defense industry must account for more variables than ever before when testing the EMI materials that play a crucial role in the operability of battlefield electronics. It’s important to take a holistic and predictive approach to testing. Leverage the wide array of advanced tools available today to successfully test EMI materials and enable the electronics that play a crucial role in ensuring fast and accurate communications in rugged environments across the globe.

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