



## **Rough waters, extreme heat and broad frequency ranges: Protecting military electronics in challenging conditions**

Engineered materials which help protect delicate electronic components and systems used by the military face extreme operating conditions. Saltwater, heat, cold, humidity, vibration, and corrosive fuels all present threats to reliable performance. Rugged designs now provide answers.

By Paul Dixon, Staff Scientist

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Military equipment – everything from radomes to fighter jets – and the soldiers who operate this equipment depend on the reliable operation of sensitive electronics. These electronics, in turn, rely on small, passive materials that mitigate stray signal interference, enhance antenna patterns, help dissipate heat, and enable survivability capabilities. Certain materials absorb or attenuate electromagnetic energy and are called microwave absorbers.

Additionally, thermal interface materials (TIMs) fill microscopic gaps between heat sources and heat dissipation components and effectively transfer unwanted heat away from sensitive integrated circuits and other delicate components.

Stray signals can interfere with crucial communications systems and degrade the performance of electronic components. Sidelobes and back scatter can reduce the quality of antenna signals. So, design engineers in the military and aerospace industries desperately need resilient and reliable microwave absorbers to protect crucial electronics and equipment against evolving threats.

## **Why protecting military electronics is so hard**

From frigid winters in Afghanistan to sweltering summers in Iraq, military electronics face the harshest weather conditions on the globe. In addition to having to operate reliably in extreme weather conditions, absorbers often rest near hot engines and may even come into contact with jet or missile fuel. Further, they often undergo violent expansion and contraction. And materials on military ships are of course at risk of corrosion.

But the challenges don't end with heat, cold, water and harsh substances like jet fuel. Absorbers also must operate effectively across a wider range of frequencies than ever before. Traditionally, military absorbers needed to be effective between 2-18 GHz. Now, as enemy radar capabilities improve, absorbers must operate effectively at frequencies as low as 200 Mhz. Absorbers also must enable 5G and weapons communications, which take place at high frequencies, including in the millimeter wave range.

An absorber's external coating protects it from harsh environmental conditions while its internal filler material has magnetic and dielectric properties that help it prevent return energy and mitigate signal interference.

### **Fluorosilicone becomes essential**

Traditional silicone absorbers can't stand up to the rigorous conditions in certain military applications, especially near jet engines or weaponry. But fluorosilicone absorbers can. They can withstand extremely high temperatures and exposure to JP8 and JP10 fuels, oils and de-icing fluids. Further, the material can handle intense expansion and contraction without stretching or cracking.

The ruggedness of fluorosilicone allows design engineers to fit absorbers in the optimal locations for signal and survivability enhancement – even if that's right near an engine. Additionally, creative uses of fluorosilicone absorbers can allow design engineers to accomplish multiple goals at once. For example, when loaded with high strength microballoons that provide insulation, a design engineer can use a fluorosilicone absorber as a thermal barrier to protect composite materials from hot gasses. Additionally, when co-molded with a conductive elastomer, a fluorosilicone absorber can not only absorb stray electromagnetic interference but also operate as a conductive ground plane. The challenging environmental conditions absorbers face in military applications make fluorosilicone an essential material for design engineers.

### **Novel filler materials cover broad range of frequencies**

Standard magnetic absorbers that work in the 2-18 GHz range are filled with standard magnetic powder. But to hide military vehicles and personnel from radar detection in low frequency ranges, materials scientists at Laird are using different alloys and even changing particle morphology from spheres to shaped materials to prevent return energy. To make absorbers effective in the millimeter wave range, Laird scientists similarly use novel fillers (in this case, carbon or lossy ceramic fillers).

The current innovation taking place in the material makeup of fillers enhances absorber performance across a broad range of frequencies. Given the crucial role absorbers play in survivability enhancement, it's hard to overstate the importance of these advancements.

### **Materials science innovations drive military and aerospace performance gains**

To meet the exacting demands of the Pentagon and defense operations of NATO countries, and ensure the reliable operation of military electronics, military and aerospace design engineers must embrace these materials science innovations. By using novel filler materials and fluorosilicone, design engineers can create tailored absorber solutions that are resilient amid harsh environmental conditions and reliable across a wide range of frequencies.

### **TIMs Beat the Heat in Safeguarding Component Performance**

As electronic warfare technologies become more sophisticated, the power density within chip packages grows, creating significant thermal management issues. Advanced thermal interface materials resist outgassing as well as the thermal pump out and delamination that can result from continuous and often intense heating and cooling cycles. Multi-functional solutions allow design engineers to address both EMI and thermal management issues and save space within high-powered chip packages.

Examples of thermal management materials useful in aerospace and defense applications can include gap filler pads, which offer a unique combination of extremely high thermal conductivity and softness. The combined features reduce mechanical stress while maintaining thermal performance. Dispensable gap fillers include liquid putty gap fillers, thermal pastes, gels, and greases. They are generally non-electrically conductive. Putty is used for filling in gaps that are present between irregular or unusual surfaces or those that do not touch one another.

Phase change materials give servers and computers of all types the ability to achieve increased processing speeds and overall functionality and reliability improvements. They take advantage of latent heat of fusion to absorb heat, but they change phase only once to allow for the material to fill up all nooks and crevices.

Electrically insulating materials provide electrical isolation, always a critical design consideration. These products offer solutions whenever reliability, cut-through resistance, and thermal conductivity are critical factors.

Lastly, thermally conductive PCBs contain thermal management materials when designers want systems which eliminate costly, secondary thermal management components, with the objective of seeking to drastically reduce system size.

In the end, these advancements on the materials science front contribute greatly to protecting the servicemen and women on the front lines in global hotspots.