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WHITEPAPER

LOW HARDNESS CONDUCTIVE ELASTOMER

The Quiet Revolution in EMI Shielding: Why Low Hardness Conductive Elastomers Are Expanding Design Possibilities Across Demanding Applications

EXECUTIVE SUMMARY

As electronic systems become more compact, more powerful, and more pervasive across industries — from advanced driver assistance systems to hyperscale data centres, from patient-connected medical devices to mission-critical defense platforms — the challenge of electromagnetic interference (EMI) shielding has fundamentally changed. It is no longer sufficient for a shielding solution to simply block unwanted electromagnetic energy. Today's engineers require materials that can help deliver effective shielding, accommodate complex mechanical constraints, operate across demanding environments, and do so without compromising the integrity of increasingly sensitive components housed within.

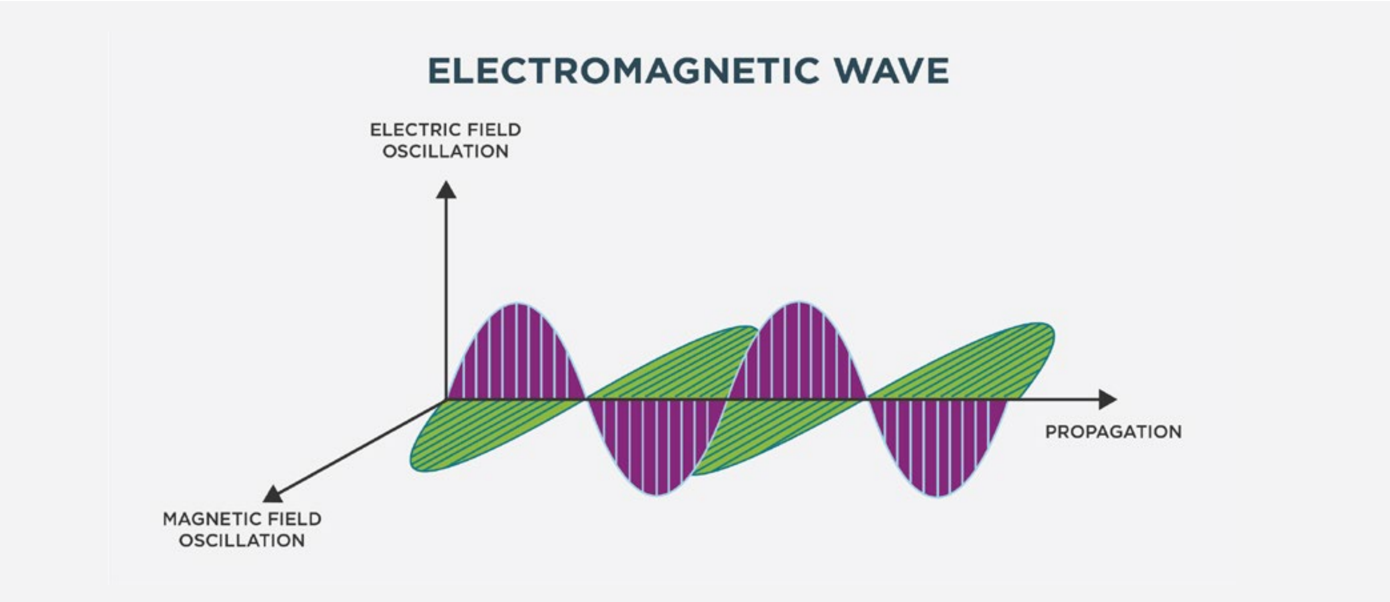
This whitepaper examines a material category that is increasingly used to support next-generation electronic design considerations: low hardness conductive elastomers. Specifically, it explores how silicone-based conductive elastomers at approximately silicone nickel graphite soft (SNGS) hardness may address design challenges that harder shielding materials may not be equally suited to resolve, subject to application-specific validation. Through a high-level analysis of the EMI shielding landscape and the typical demands of ADAS (Advanced Driver Assistance Systems), data center infrastructure, medical devices, and defense systems, this paper provides engineers with general technical rationale and design considerations for evaluating low durometer conductive elastomers in their next project.

1. THE EVOLVING EMI LANDSCAPE: A GROWING CHALLENGE

Electromagnetic interference has been a persistent concern in electronic design for decades. However, several converging trends are amplifying the complexity of the EMI challenge:

Increasing Operating Frequencies and Density

Modern electronic systems operate across ever-widening frequency bands. 5G communication infrastructure, high-speed data links, advanced radar systems, and high-frequency switching power electronics all generate electromagnetic energy across spectra ranging from kilohertz to tens of gigahertz. As circuit density increases and enclosures shrink, the proximity of noise-generating and noise-sensitive components creates EMI coupling paths that were not present in earlier, more spacious designs.



Stricter Regulatory and Standards Requirements

Global electromagnetic compatibility (EMC) standards continue to evolve. Whether governed by automotive standards, FCC/CE requirements for commercial electronics, or military specifications such as MIL-DTL-83528 for conductive gaskets, applicable regulatory requirements may become more demanding over time. Engineers must not only meet shielding effectiveness thresholds but do so with documented, repeatable performance across the product lifecycle at the finished-product and system level.

Miniaturization and Component Sensitivity

The trend toward miniaturization means that the components requiring protection are smaller, more delicate, and more susceptible to both electromagnetic and mechanical damage. The closure forces applied by traditional shielding gaskets—forces that were acceptable in larger, more robust enclosures—can now pose a real risk to fine-pitch connectors, thin PCB substrates, and sensitive semiconductor packages.

Market Growth Reflects Urgency

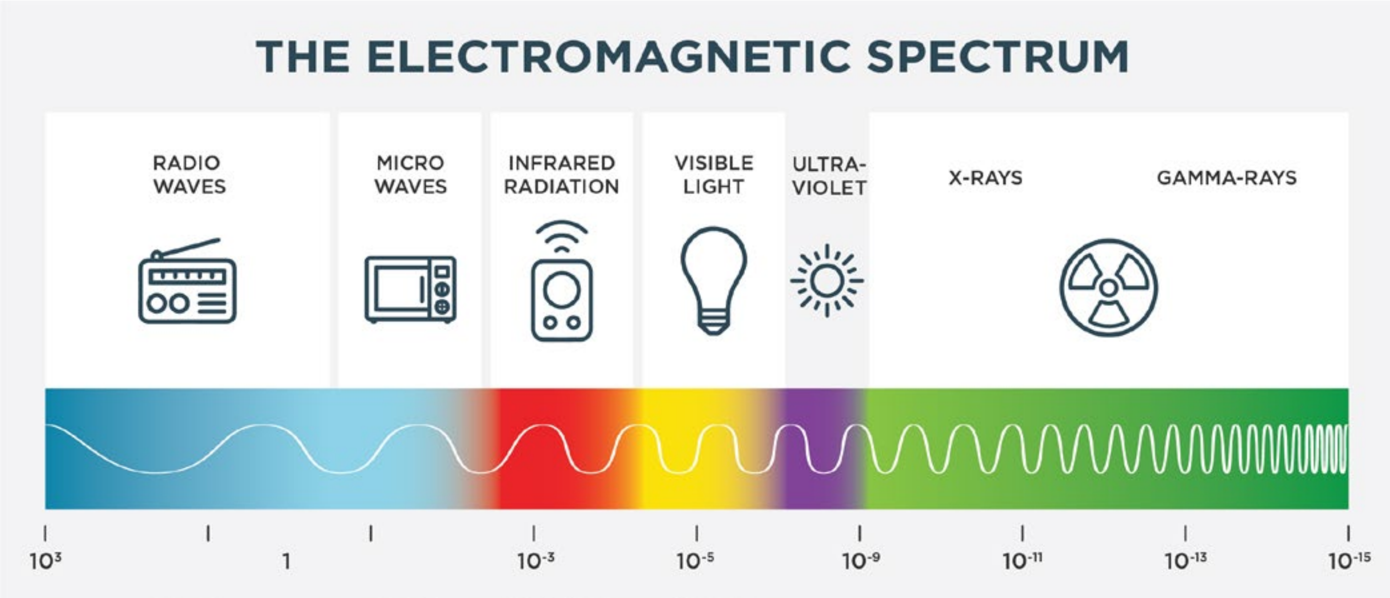
The global EMI shielding market is projected to grow from USD 8.04 billion in 2026 to USD 10.90 billion by 2032, registering a CAGR of 5.2% (https://www.marketsandmarkets.com/PressReleases/emi-shielding.asp; figures are third-party market projections and subject to change)]. This growth is driven not by a single industry but by the expansion of electromagnetic complexity across automotive, telecommunications, healthcare, defense, and industrial sectors.

2. UNDERSTANDING CONDUCTIVE ELASTOMERS AS EMI SHIELDING SOLUTIONS

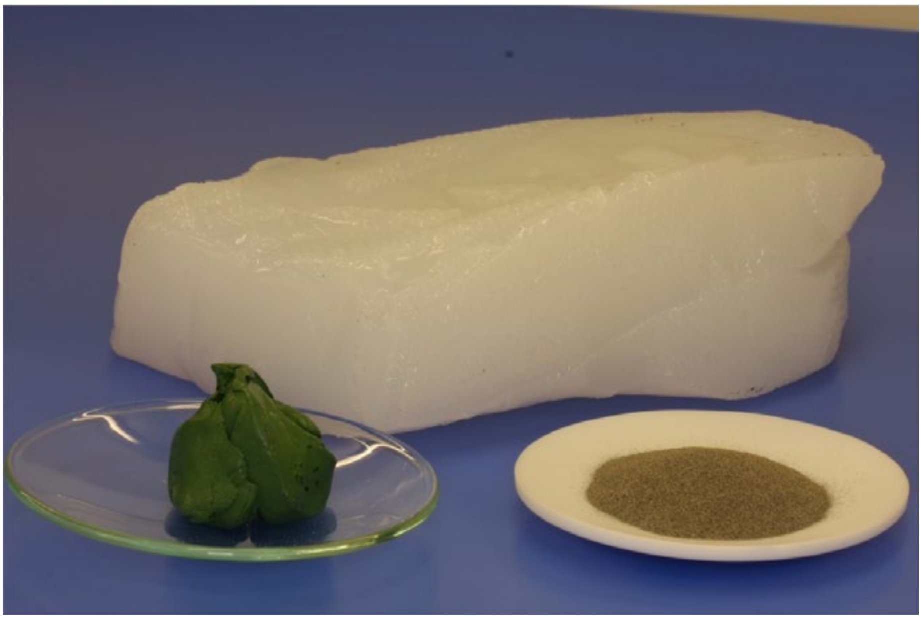
2.1 How Conductive Elastomers Work

Conductive elastomers are composite materials consisting of an elastomeric base — typically silicone — filled with conductive particles. When compressed between the mating surfaces of an electronic enclosure, they form a continuous conductive path that bridges seams and gaps, preventing electromagnetic energy from leaking in or out.

The critical property that makes a conductive elastomer gasket an effective EMI seal is its ability to provide good electrical conductivity across the gasket-to-surface interface while simultaneously maintaining a physical environmental seal against moisture, dust, and other contaminants. This dual functionality — electromagnetic shielding combined with environmental sealing — is a defining advantage of conductive elastomers over many alternative shielding approaches.



2.2 Filler Systems and Their Implications



The choice of conductive filler influences much of a conductive elastomer's electrical performance, cost profile, and application suitability:

- Nickel graphite-filled elastomers typically provide a balanced combination of good shielding effectiveness, moderate cost, and strong environmental stability — making them suitable for a broad range of applications from automotive to defense, subject to application-specific validation.
- Silver-copper and silver-aluminum fillers offer alternative performance characteristics that may be suitable for certain applications.

Silicone nickel graphite soft (SNGS) formulations have gained traction for applications that require robust EMI shielding across a wide frequency range while also demanding environmental resilience across a broad temperature spectrum, when qualified within the intended application.

2.3 The Role of Hardness in Design

Hardness, measured on the Shore A durometer scale, is one of the most consequential properties when selecting a conductive elastomer for a given application. Hardness directly influences:

- Closure force requirements — how much compressive force is needed to achieve the specified deflection and, therefore, adequate surface contact for shielding.
- Surface conformability — how effectively the gasket material can fill micro-irregularities and accommodate component height variation across a sealing surface.
- Stress on adjacent components — the mechanical load transferred to PCBs, connectors, housings, and other elements in close proximity to the gasket.
- Seal integrity over time — the material's ability to maintain elastic recovery and contact pressure after prolonged compression.

Traditional conductive elastomers have commonly been available at hardness values of 55 Shore A and above. While suitable for many legacy applications, these harder materials may be less well suited to certain characteristics of the new generation of compact, densely populated, and mechanically sensitive electronic enclosures.

3. THE CASE FOR LOW HARDNESS: WHY SILICONE NICKEL GRAPHITE SOFT (SNGS) MAY BE ADVANTAGEOUS

A conductive elastomer at silicone nickel graphite soft (SNGS) hardness may offer additional design flexibility within their enclosure designs. The advantages can, in appropriate applications, expand available design options.

3.1 Low Closure Force: Protecting Sensitive Assemblies

At silicone nickel graphite soft (SNGS), the material compresses at a lower force than harder alternatives. This may be beneficial in applications where:

- Thin-walled housings cannot withstand high clamping loads without deformation.
- PCBs carrying surface-mount components risk solder joint fracture or trace damage under excessive compressive force.
- Latching or fastening mechanisms must remain lightweight and compact.
- Automated assembly processes require predictable, low-force insertion of covers and enclosure panels.

The ability to achieve effective sealing and shielding with low closure force may allow engineers to design lighter fastening structures, use thinner enclosure walls, and reduce the risk of mechanically induced failures , subject to overall system design.

3.2 Superior Surface Conformability

Mating surfaces typically exhibit some level of surface irregularity in real-world conditions. Machining tolerances, casting variations, the presence of raised solder pads, and component height differences all create an uneven sealing landscape. A silicone nickel graphite soft (SNGS) elastomer is designed to conform to these irregularities more readily than a harder material, helping maintain continuous surface contact which may support continuous electromagnetic shielding across the entire perimeter of the seal.

This conformability is particularly relevant in enclosures with complex geometries or where cost constraints prevent precision machining of all mating surfaces.

3.3 Accommodation of Component Height Variation

In densely populated electronic assemblies, components near the enclosure edge may vary in height. A soft, compliant conductive elastomer may help bridge these height differences without creating gaps — gaps that would otherwise become EMI leak paths. This flexibility supports flexible design by helping accommodate component height variation without requiring redesign of the PCB layout or the enclosure geometry.

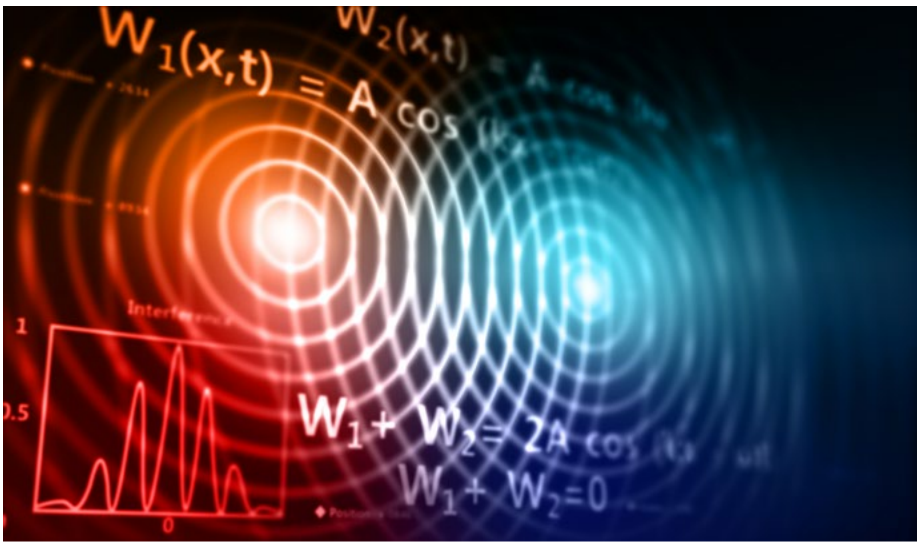
3.4 Long-Term Durability

Despite its softness, a well-formulated silicone nickel graphite soft (SNGS) conductive elastomer is designed to maintain performance over time. Key durability metrics, as measured under applicable test conditions specified in the product datasheet, include:

- Compression set of 20% — indicating the material retains a substantial portion of its original thickness after prolonged compression, helping maintain contact pressure and seal integrity.
- Operating temperature range of –55°C to +150°C —as specified in the applicable product datasheet.
- Tear strength of 8 N/mm and elongation of 150% — providing mechanical robustness during installation and in service (values per applicable product datasheet; actual performance may vary based on application conditions).

3.5 Consistent Shielding Performance

- A low hardness material does not inherently compromise electromagnetic performance. With electric field shielding effectiveness characterized across 200 kHz to 40 GHz, and magnetic field shielding from 10 kHz to 30 MHz (per internal test data referenced in the applicable product datasheet), the material is designed to support a broad range of EMI shielding requirements in modern electronic systems.
- Shielding effectiveness testing in accordance with MIL-DTL-83528 (Section 4.5.12) is intended to support engineers in evaluating compliance with the applicable specification; system-level compliance remains the responsibility of the finished-product manufacturer.



4. APPLICATION DEEP DIVE: WHERE LOW HARDNESS CONDUCTIVE ELASTOMERS MAY OFFER DESIGN BENEFITS

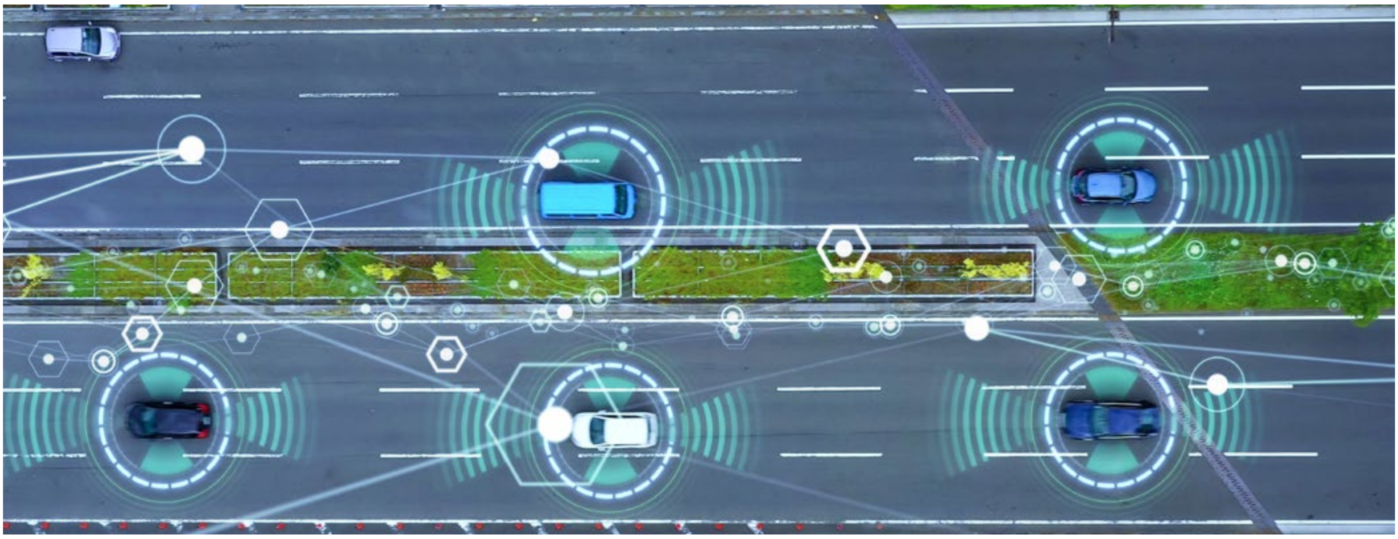
4.1 ADAS and Automotive Electronic Enclosures

The Challenge: Advanced Driver Assistance Systems represent one of the most demanding EMI environments in modern engineering. ADAS modules — including radar, lidar, cameras, and sensor fusion processors — must operate with high reliability while coexisting in electromagnetically dense vehicle architectures. EV powertrains introduce additional high-and low-frequency noise from inverters and switching converters.

Automotive enclosures are subject to wide temperature swings (from –40°C in cold-start conditions to well above 100°C under hood), vibration, and long service life requirements (which may extend beyond 10 years depending on vehicle program requirements)]. Simultaneously, the push toward vehicle lightweighting demands thinner housings and lower-profile electronics.

Why Low Hardness May Be Advantageous: A silicone nickel graphite soft (SNGS) conductive elastomer may support ADAS enclosure designers in addressing EMI shielding requirements without over-engineering the mechanical structure of the housing. The low closure force may help reduce compressive stress on sensitive radar transceivers and processor packages. The wide operating temperature range (–55°C to +150°C) is intended to support stable performance across automotive thermal cycles, subject to application-specific validation. The material's conformability accommodates the manufacturing tolerances typical of die-cast aluminum or injection-molded enclosures used in automotive applications.

For EV battery pack applications, where EMI from high-current switching must be contained while the enclosure must also be sealed against moisture ingress, the dual shielding-and-sealing capability of a conductive elastomer may reduce the need for separate EMI and environmental gaskets —potentially simplifying the design, reducing part count, and saving assembly cost.



4.2 Data Center and Connectivity Infrastructure

The Challenge: Data centers are electromagnetic ecosystems of extraordinary density. Thousands of high-speed servers, switches, and storage devices operate in close proximity, each generating and susceptible to EMI. As data rates increase — driven by 400G and 800G networking, AI workloads, and cloud computing demand — the frequency content of signals and their associated EMI signatures push into higher bands where shielding becomes more difficult.

Simultaneously, data center operators demand equipment that is easy to service, with enclosures that can be opened and resealed repeatedly without material degradation affecting EMI performance. Thermal management is paramount, and every design element — including EMI gaskets — must not impede airflow or add unnecessary thermal resistance.

Why Low Hardness May Be Advantageous: Server and networking equipment enclosures frequently use sheet metal or thin-gauge housings where high gasket compression forces would cause lid deformation or gap formation — the opposite of the intended shielding effect. A silicone nickel graphite soft (SNGS) conductive elastomer is designed to achieve effective contact at low compression, maintaining shield integrity even on lightweight panels , subject to system-level validation].

The material's low compression set (20%) is designed to support] continued shielding after repeated opening and closing of service access panels — a relevant requirement for data center equipment with high service frequency. For 4G/5G connectivity equipment deployed at cell sites and edge locations, the material's environmental sealing capability and broad temperature tolerance provide additional design utility in outdoor or semi-outdoor installations.

4.3 Medical Devices

The Challenge: In the medical device industry, EMI shielding is an important element of overall device performance and regulatory compliance, which is assessed at the finished-device level by the device manufacturer. Medical devices such as patient monitors, imaging equipment (MRI, CT, ultrasound), surgical navigation systems, and implantable device programmers must operate within applicable EMC requirements in electromagnetically complex hospital environments filled with wireless communications, electrosurgical tools, and other radiating equipment.

Why Low Hardness May Be Advantageous: Medical device enclosures are frequently designed with plastic housings and thin walls to minimize weight — particularly for portable devices. A soft conductive elastomer at silicone nickel graphite soft (SNGS) is designed to achieve the necessary gasket-to-housing contact without deforming these lightweight enclosures or cracking brittle plastic snap-fit features.

The silicone base material offers inherent advantages in medical contexts: it is chemically inert, resistant to common hospital-grade disinfectants, and performs reliably across many sterilization temperature ranges used in medical environments; suitability for a specific sterilization method must be validated by the device manufacturer. RoHS compliance is available as specified in the applicable product documentation, and the availability of a PFAS-free extrusion option may support customers in addressing the growing regulatory scrutiny around per- and polyfluoroalkyl substances in healthcare applications.

TE conductive elastomers are components and are not medical devices. TE makes no representation regarding their suitability for use in life-support, implantable, or other high-risk medical applications. Any use in such applications requires case-by-case evaluation by the device manufacturer and, where applicable, prior written agreement with TE.

4.4 Aerospace, Defense, and Military Systems

The Challenge: Defense and aerospace applications represent among the most demanding EMI shielding requirements. Communication systems, radar, electronic warfare equipment, and avionics must operate reliably in contested electromagnetic environments while meeting stringent military EMC standards. These systems are also subject to demanding mechanical stress — shock, vibration, altitude pressure changes — and must perform across the widest possible temperature ranges.

Military procurement specifications, including MIL-DTL-83528, establish rigorous qualification requirements for conductive elastomer gaskets used in defense enclosures. Any application within controlled or regulated defense programs may be subject to additional export control, ITAR/EAR, or country-specific requirements, which remain the responsibility of the customer.

Why Low Hardness May Be Advantageous: Defense enclosures often contain the most sensitive and highest-value electronics in any application domain. The ability to provide effective shielding while minimizing compressive stress on these components is a significant design advantage. A silicone nickel graphite soft (SNGS) conductive elastomer is designed to support this balance and is characterized for shielding effectiveness per MIL-DTL-83528; final qualification and compliance are the responsibility of the finished-product manufacturer.

The material's operating temperature range of –55°C to +150°C is aligned with a wide range of typical military operational envelopes, subject to application-specific validation. The availability of custom profiles through both extrusion and molding grades enables defense engineers to design gaskets that match the complex geometries of ruggedized enclosures, waveguide flanges, and access panels.

5. DESIGN CONSIDERATIONS FOR ENGINEERS

The following are general engineering considerations. Final material selection, qualification, and validation remain the responsibility of the design engineer, OEM or finished-product manufacturer.

When evaluating a low hardness conductive elastomer for a new design, engineers should consider the following:

5.1 Material Grade Selection

Low hardness conductive elastomers are available in both molding grade and extrusion grade formulations. The choice depends on the application:

- Extrusion grades (included vulcanized) are typically suited for producing continuous gasket profiles in standard or custom cross-sections —often used for perimeter seals on enclosure lids and access panels.
- Molding grades enable the production of complex three-dimensional gasket geometries, O-rings, and custom-shaped seals that conform to non-planar sealing surfaces.
- Sheet Materials can also be cut to meet custom flat gasket design requirements.



5.2 Compression and Deflection Planning

Engineers should design their gasket grooves and mating surfaces to achieve the deflection necessary for effective electrical contact, keeping in mind that a silicone nickel graphite soft (SNGS) material will achieve this contact at a lower force than a harder alternative. This may allow the use of fewer or lighter fasteners and thinner enclosure walls.

5.3 Environmental Sealing Integration

One of the most significant design efficiencies available with a conductive elastomer is the potential combination of EMI shielding and environmental sealing in a single gasket element. Engineers should evaluate whether a single low-hardness conductive elastomer gasket can replace a two-gasket system (one for EMI, one for environmental protection), reducing part count, simplifying assembly, and eliminating the risk of gasket-to-gasket interference, based on application-specific validation.

5.4 Frequency Range Alignment

The shielding effectiveness of the material should be validated against the specific frequency range of concern for the application. With electric field shielding from 200 kHz to 40 GHz and magnetic field shielding from 10 kHz to 30 MHz (per applicable product datasheet), the material is designed to address frequency ranges relevant to many automotive, data center, medical, and defense applications. However, engineers working with specific EMC standards should verify alignment with their particular test requirements.

6. THE BROADER TREND: MATERIAL INNOVATION AS A DESIGN ENABLER

The development of modern silicone nickel graphite soft (SNGS) conductive elastomers reflects a broader trend in electronic materials engineering: the recognition that passive components and materials are not merely constraints to be managed, but important enablers of system-level performance.

For too long, EMI gasket selection was treated as a late-stage design decision — a problem to be solved after the enclosure geometry, PCB layout, and component selection were finalized. This approach often led to compromises: over-specified gaskets that imposed unnecessary forces, or under-specified gaskets that failed to provide adequate shielding.

The availability of low hardness conductive elastomers with validated, specification-grade shielding performance empowers engineers to integrate EMI shielding considerations earlier in the design process — informed by the knowledge that a soft, conformable, high-performing material exists that can accommodate the mechanical and electromagnetic realities of the final design.

7. CONCLUSION

The electronics industry is at an inflection point. The systems we are designing — whether for advanced driver assistance systems, next-generation data centers, patient-connected medical devices, or advanced defense platforms — are simultaneously more capable and more exposed to electromagnetic interference than anything that has come before.

Addressing this challenge requires materials that do more than simply block EMI. Engineers need shielding solutions that work within the mechanical, thermal, and environmental constraints of modern electronic enclosures — solutions that help enable design rather than constrain it.

Low hardness conductive elastomers, at silicone nickel graphite soft (SNGS), represent a material category that can support these design objectives in appropriate applications. By combining characterized EMI shielding across a broad frequency spectrum with low closure force, strong conformability, environmental sealing, and long-term durability across demanding temperatures, these materials may provide engineers a new degree of freedom in enclosure design.

As electronic complexity continues to grow across every industry, the engineers who understand and leverage the capabilities of advanced shielding materials may be best positioned to deliver systems that are not only electromagnetically compliant, but fundamentally better designed.

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