Advanced Technologies

High-precision laser performance with ultra-low outgassing silicone

INTRODUCTION

Laser technology is a critical element for our digital age. The stability and precision of a laser's output is essential to its effective long-term operation in research, communications, aerospace and defense applications.

A leading manufacturer of high-precision lasers sought ways to improve the stability and operational life of the lasers they supply to space applications, such as communications satellites and research and exploration spacecraft. It is now common for these vehicles to operate in space for years or even decades; in turn, the lasers used in this generation of spacecraft must also operate with the highest degrees of reliability for years at a time.

As a result, the company started to investigate how it could use ultra-low outgassing silicones to hold the laser's optical components in place and further reduce the risk of contamination of delicate laser optics.

The extreme temperatures and vacuum conditions of space present unique environmental challenges. Unless specially formulated, these conditions can cause any volatiles in a material – whether it's silicone or some other material – to outgas and possibly damage sensitive lenses, electronics and other surfaces. As a result, low outgassing silicones have become critical to the successful exploration and commercial use of space.

The laser manufacturer was already using Avantor® NuSil® brand low outgassing silicone adhesives in a different application. The company engaged with NuSil silicone experts to begin evaluating the use of ultra-low outgassing silicones as a solution for this specific challenge. Together, the team determined that a higher-purity, ultra-low outgassing silicone would provide the company with enhanced performance: it would reduce the risk of contamination and shrinkage, safeguarding the optical lens and, in turn, extending the life of the laser.

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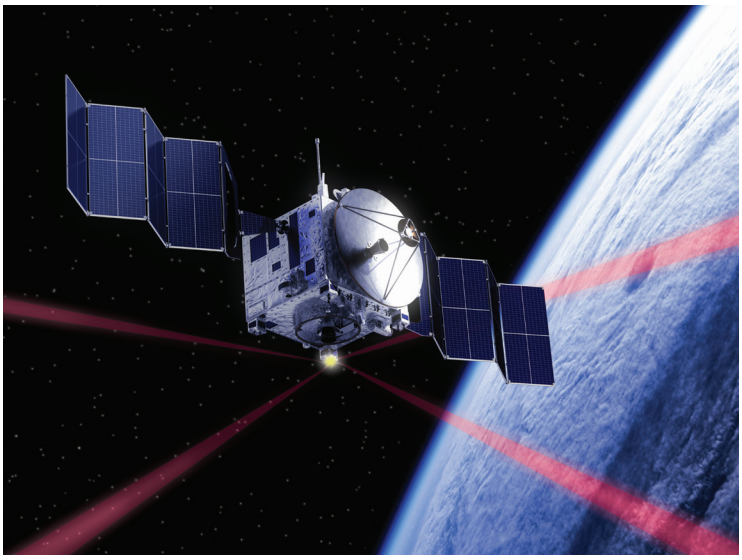
> — Robert Umland
> **Director, Advanced Technologies for NuSil**



CASE STUDY

The difference between low outgassing and ultra-low outgassing silicones is established through measurements of the levels of volatile materials that are released over time by these types of silicones—ultra-low outgassing silicones having significantly lower amounts of volatiles released.

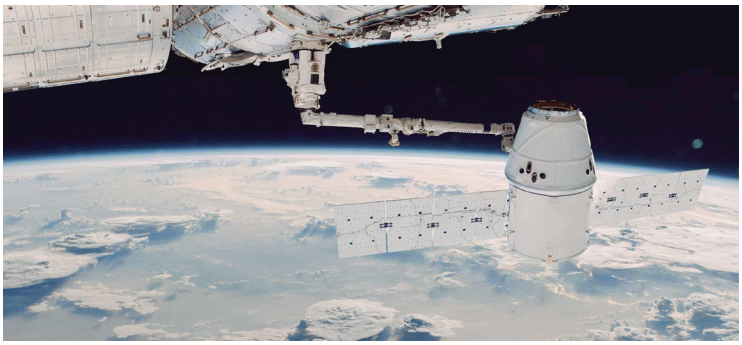
NASA has established rigorous testing standards for materials used in space applications, which measure factors such as total mass loss (TML) and the amount of collected volatile condensable material (CVCM). NuSil offers both low outgassing silicones and ultra-low outgassing silicones, with the low outgassing silicones demonstrating ≤ 1% maximum TML and ≤ 0.1% maximum CVCM. Its ultra-low outgassing materials exceed the ASTM E595 standards by an order of magnitude, with ≤ 0.1% maximum TML and ≤ 0.01% maximum CVCM.

Additionally, NuSil silicones are backed by a documented quality management system certified to AS9100 and manufactured in an ISO 9001 facility. Products are tested on a lot-to-lot basis against the standards set forth by NASA and the European Space Agency (ESA) to ensure reliable performance.

"We take great pride in our ability to continually innovate silicone technology to meet and exceed our customer's requirements," said Robert Umland, Director, Advanced Technologies for the NuSil brand. "We are an industry leader in developing silicones formulated to deliver long-lasting stability in the harsh environment of space, and our next-generation, ultra-low outgassing silicones continue that established track record of innovation."

IMPROVED LASERS REQUIRE IMPROVED SILICONES

Lasers generate heat, so thermally conductive materials that dissipate that heat in a controlled fashion are essential. The thermally conductive materials also need to be extremely stable and not outgas over time. When a polymer like silicone outgasses, it can deposit residue on surfaces such as laser optics, degrading their performance and the quality and purity of the coherent light they output.



The laser manufacturer used a thermally conductive, low outgassing silicone from NuSil to create a multilayered adhesive to hold the laser lenses in place. The silicone is formulated to maintain operational performance over temperatures ranging from -120˚C up to 300˚C and is highly purified using proprietary processes to mitigate condensation of volatiles and prevent material degradation.

Over a multiyear period, the ultra-low outgassing adhesive was tested in the company's lasers, and the teams worked through a series of revision-controlled material specifications. The silicone went through multiple development cycles to meet exacting performance parameters.

As the customer began developing larger, more powerful lasers with longer operating life, the NuSil ultra-low outgassing silicone allowed the company to lower their risk of failure and enhance the performance of their devices. The laser manufacturer has now fully transitioned to using the custom ultra-low outgassing, thermally conductive silicone adhesive for their laser optics assembly.

"Our ultra-low outgassing materials are just one example of how we approach innovation," Umland added. "We constantly drive improvements in our silicone technology that exceed existing standards, so we're ready to provide solutions that satisfy our customer's evolving needs."

GET STARTED

When your advanced applications require space-grade silicones, we're ready to supply you with the right low outgassing solution you need.

www.avantorsciences.com/nusil

To learn more, visit **avantorsciences.com/nusil/spacegradesilicone** or contact NuSil silicone experts today at **silicone@nusil.com** or **+1 (805) 684-8780**.

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