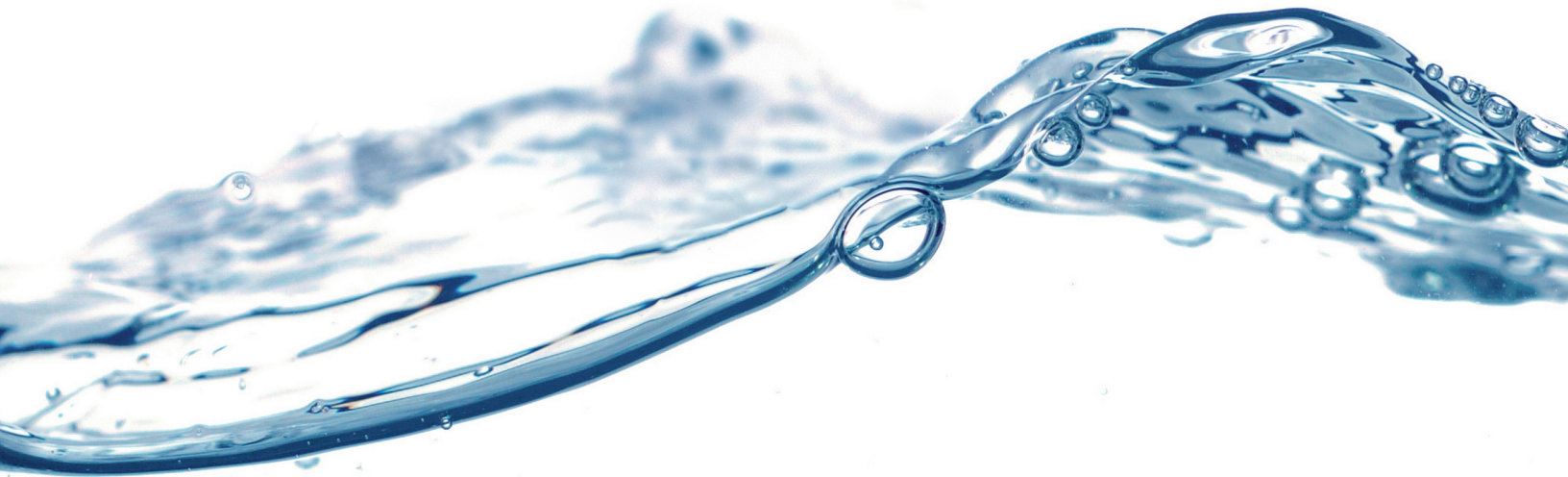




Opteon™ | Vertrel™

Specialty Fluids by The Chemours Company

Innovative Fluids That Deliver
Superior Performance



Chemours™

Chemours is a dynamic science company with a strong commitment to protecting the environment. Because of that commitment, we are focused on continuing to develop innovative products that meet the demanding specifications of our customers while providing safer cleaning solutions that are more sustainable for the environment.

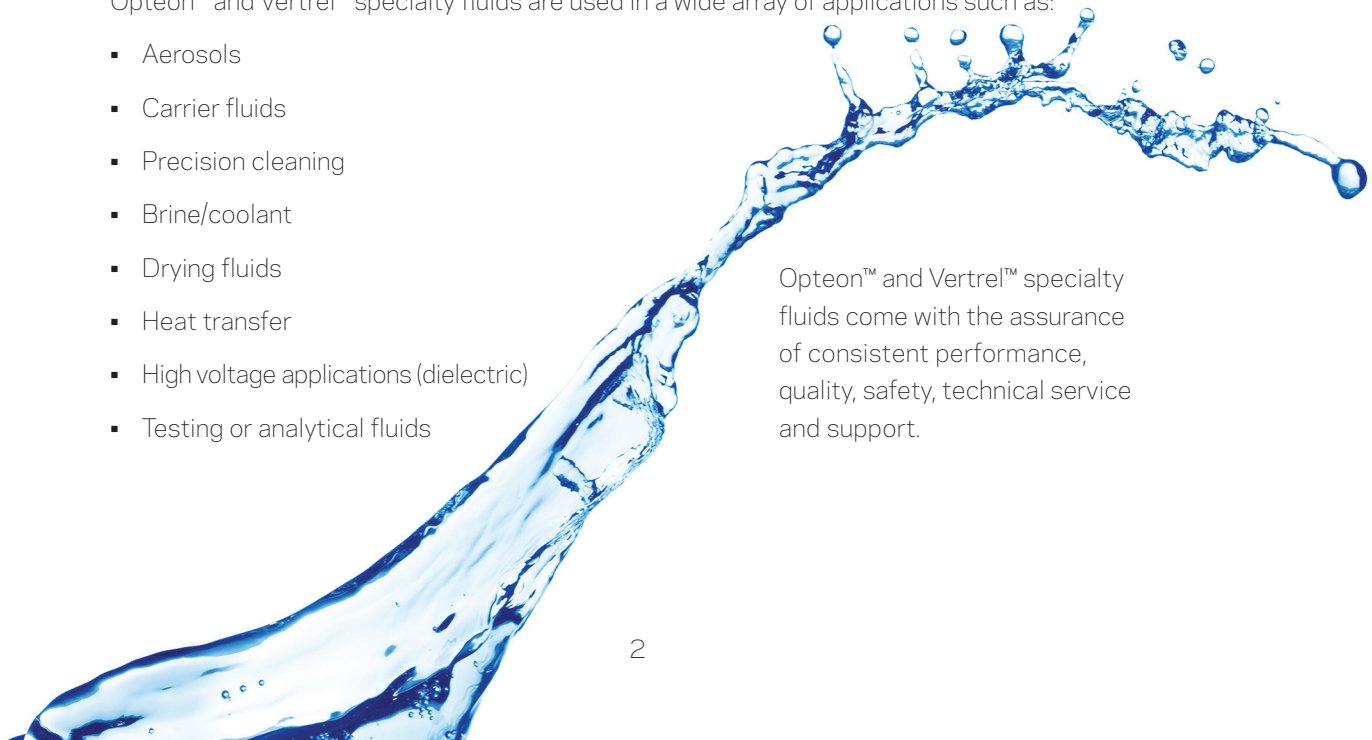
Over the decades, Chemours has a rich history in the specialty fluids market. From our DuPont roots came Freon™ in the 1930's. Always a step ahead of the ever-changing regulatory landscape, we brought you Vertrel™ in the early 2000's. Today, we bring you Opteon™—a line of zero ODP, low GWP specialty fluids products developed with HFO technology. Together, the Opteon™ and Vertrel™ specialty fluids portfolios provide customers with a broad and versatile mix of product options that are better for your business performance and the environment. By virtue of better performance and environmental properties, Opteon™ and Vertrel™ specialty fluids have been proven to be ideal replacements for solvents with ozone depleting and global warming potential. Opteon™ and Vertrel™ are used as replacement fluids for products such as CFC-113, 1-1-1 trichloroethane, HCFC-141b, HCFC-123, HCFC-225, PFCs, nPB-based solvents, perchloroethylene, trichloroethylene and hydrofluoroethers.

What are specialty fluids by Chemours?

The specialty fluids portfolio by Chemours is made up of Opteon™ and Vertrel™ products. Vertrel™ specialty fluids are HFC-based products and Opteon™ specialty fluids are HFO (hydrofluoroolefin)-based products with zero ODP and low GWP. Both portfolios provide a range of solvency power, compatibility with a variety of materials and high performance. The unique properties of Opteon™ and Vertrel™ specialty fluids include a low boiling point, low heat of evaporation, excellent solvent retention, low surface tension, low viscosity, nonflammability, chemical and thermal stability, low toxicity and ease of recovery by distillation. Opteon™ and Vertrel™ products are compatible with a broad range of materials, metals, plastics and elastomers.

Opteon™ and Vertrel™ specialty fluids are used in a wide array of applications such as:

- Aerosols
- Carrier fluids
- Precision cleaning
- Brine/coolant
- Drying fluids
- Heat transfer
- High voltage applications (dielectric)
- Testing or analytical fluids



Opteon™ and Vertrel™ specialty fluids come with the assurance of consistent performance, quality, safety, technical service and support.

Environmental Properties

Because of their zero ozone depletion and low global warming potential, Opteon™ specialty fluids are accepted by key governmental and environmental regulatory agencies in the United States and most countries around the globe.

Please check with the Chemours office closest to you for acceptance of Opteon™ and Vertrel™ products in your specific country.

Safety and Handling

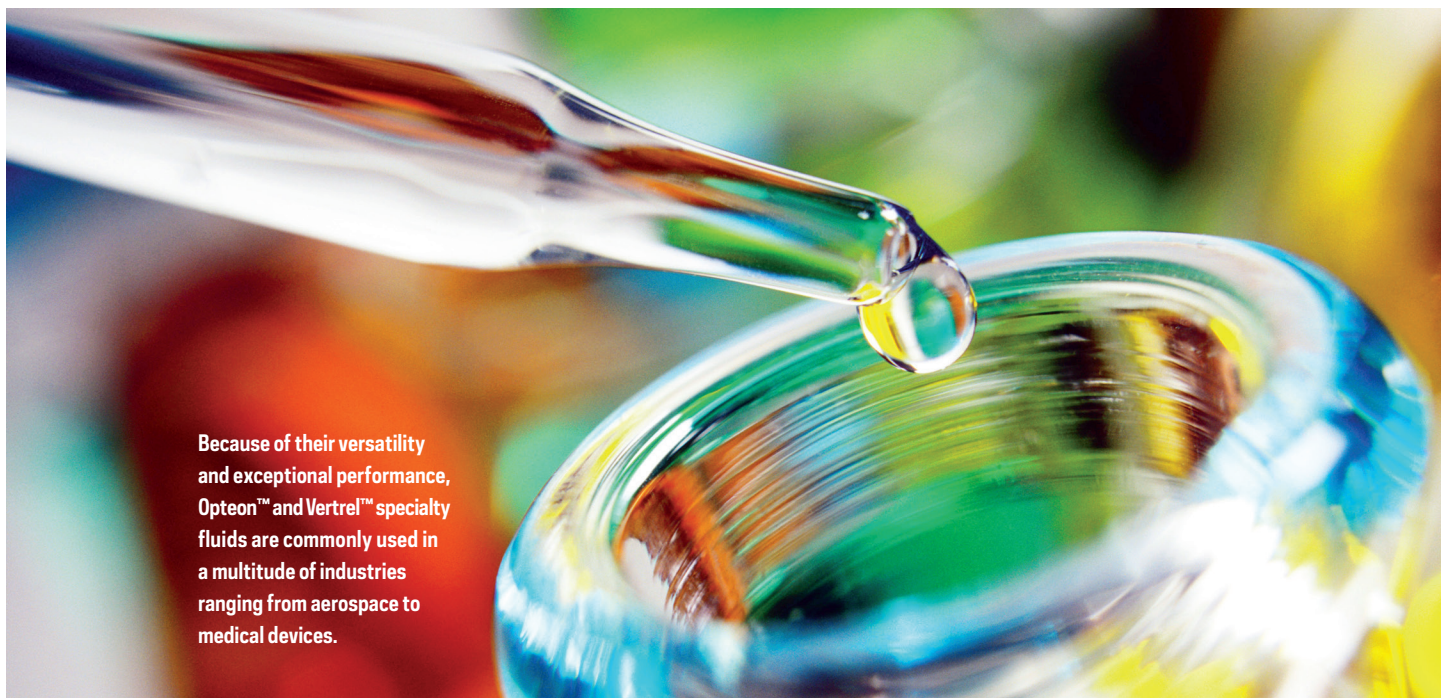
Opteon™ and Vertrel™ specialty fluids are generally safe; but, as with any chemical, it is important for all users to be well-informed regarding product properties, safe handling and use. Safety Data Sheets (SDS) for all products can be found at vertrel.com and through your distribution partner.

Flammability/Decomposition

Most Opteon™ and Vertrel™ specialty fluids do not exhibit a closed-cup flash point and are not classified as flammable liquids by the National Fire Protection Association (NFPA) or Department of Transportation (DOT). However, there are some blends that have vapor flammability limits in air. Specific flammability information is provided for each blend on the website, vertrel.com.

Human Health

Opteon™ and Vertrel™ specialty fluids have low inhalation toxicity and pose little risk of adverse health effects when airborne exposure is maintained below established limits. All Opteon™ and Vertrel™ blends have an acceptable exposure limit (AEL) of >100. For information on the exposure limits for each Opteon™ and Vertrel™ blend, please visit our website, vertrel.com.



Because of their versatility and exceptional performance, Opteon™ and Vertrel™ specialty fluids are commonly used in a multitude of industries ranging from aerospace to medical devices.

Opteon™ and Vertrel™ specialty fluids provide the high performance, consistent quality and high levels of safety that are synonymous with the Chemours brand.



Aerosols

Opteon™ and Vertrel™ specialty fluids are an ideal choice for replacing HCFC-141b in aerosol formulations

due to their excellent environmental properties and ability to meet the diverse requirements of formulators. Specifically, Opteon™ and Vertrel™ specialty fluids provide outstanding cleaning performance; are non-flammable; feature reduced volatile organic compound (VOC) content and low toxicity; are quick drying; leave no residue; and offer good materials compatibility.



Brine/Coolant

Opteon™ and Vertrel™ are very effective brine/coolants that prevent a part or device from overheating. In a brine/coolant application, Opteon™ or Vertrel™ is enclosed in a heat exchanger system. When Opteon™ and Vertrel™ come in contact with parts at high temperatures, they evaporate—cooling the parts. As Opteon™ or Vertrel™ moves to the cooler side of the heat exchanger system, it condenses back into liquid state. These products are used to continuously cool down parts that could become damaged due to excessive heat.



Carrier Fluids

Opteon™ and Vertrel™ specialty fluids are ideal replacements for PFCs in carrier fluid/lubricant deposition applications, especially in the hard disk drive and medical device industries.

In this application, Opteon™ and Vertrel™ are used to deposit lubricant on a substrate. Because Opteon™ and Vertrel™ are fast drying, they evaporate—leaving behind an even coating of the lubricant. The thickness of the coating can be controlled by the rate at which the substrate is removed from the solution.



Cleaning Solvents

Developed with both performance and the environment in mind, Opteon™ and Vertrel™ specialty fluids are used for a wide variety of cleaning applications, including vapor degreasing; light and heavy soil removal; particulate/ionic removal; oxygen systems cleaning; precision cleaning; and defluxing. Due to their low viscosity, low surface tension and high liquid density, Opteon™ and Vertrel™ specialty fluids enable effective wetting and ensure excellent cleaning performance.

In electronics manufacturing, the trend toward tighter clearances has made defluxing circuit boards more critical and more challenging than ever before. Opteon™ and Vertrel™ specialty fluids have proven to be the ideal solutions due to their low surface tension and ability to quickly and effectively wash away contaminants such as solder paste.

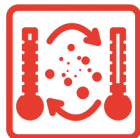
Opteon™ and Vertrel™ specialty fluids are versatile enough to work in almost any cleaning application and are widely used in critical industries such as defense, aerospace, electronics, optics and medical device manufacturing.



Drying

Due to their unique combination of properties, Opteon™ and Vertrel™ specialty fluids are excellent drying solutions after aqueous cleaning, eliminating the problems that commonly occur with oven, hot air knife or tumble drying. For example, due to their lower surface tension, Opteon™ and Vertrel™ eliminate the problem of water getting trapped in a complex part because they can get into small gaps and blind holes and push the water out. The low boiling point of our products enables them to evaporate quickly—allowing parts to be processed faster, resulting in lower energy costs.

Opteon™ and Vertrel™ specialty fluids are used extensively for drying in a wide variety of industries, such as jewelry and watchmaking, and automotive tool manufacturing.



Heat Transfer

Opteon™ and Vertrel™ specialty fluids, particularly Opteon™ SF10, offer a convenient and affordable solution to meet the complex challenges of heat transfer applications. Their operating temperature range and thermal stability guarantee continued effectiveness over several boiling cycles.

Opteon™ and Vertrel™ specialty fluids are typically used as heat transfer fluids for semiconductors, semiconductor tools and pharmaceutical manufacturing.



High Voltage

Opteon™ and Vertrel™ are widely used as dielectric or testing fluids in many high voltage applications. The dielectric properties and breakdown voltage of Opteon™ and Vertrel™ make them ideal choices for this application. Typical uses include electrical testing of insulation sleeves, commercial glove testing and sleeve testing equipment.



Testing

As testing fluids, Opteon™ and Vertrel™ specialty fluids are used for a wide range of applications, including fingerprint extraction, wastewater analysis and virus extraction. The properties that make our products ideal for these kinds of applications are their materials compatibility, nonflammability, fast evaporation and good solubility of deposition fluids.



In the aerospace industry, Opteon™ and Vertrel™ specialty fluids are used for a wide variety of applications in manufacturing and maintenance, as well as during flight.

Cleaning Landing Gear

Water entrapment in the landing gear is a major concern because freezing can fracture parts. Opteon™ and Vertrel™ are used extensively to clean landing gear, eliminating the problems posed by water, and are specified by NASA to be used on the sealed system of the space shuttle.

Oxygen Service

Opteon™ and Vertrel™ have been used extensively for servicing oxygen systems. The parts that are cleaned using Opteon™ and Vertrel™ are critical for ensuring a stable oxygen supply in the aircraft.

Defluxing/Cleaning of Electronics

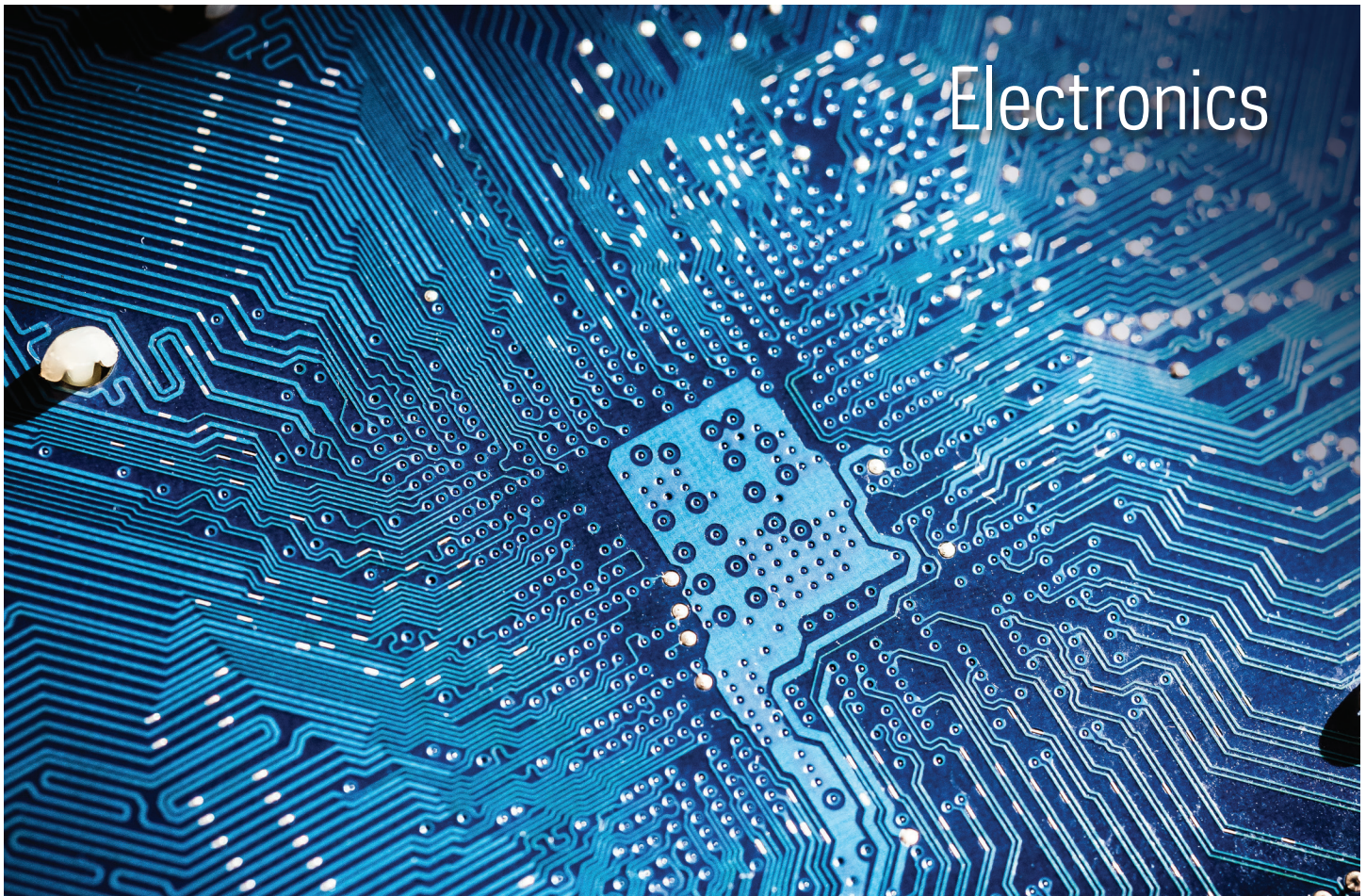
The aerospace industry uses critical electronics and circuits whose failure can be catastrophic. To ensure reliable and trouble-free performance, Opteon™ and Vertrel™ are often the first choice of solvent used to deflux and clean printed circuit boards (PCBs) after soldering.

Microwave Systems

Opteon™ and Vertrel™ have been used as heat transfer fluids in power semiconductor or IGBT modules used in microwave ovens on airplanes. In such cases, Opteon™ and Vertrel™ specialty fluids ensure hot meals on a flight.

Drilling of Micro-Holes

A lot of heat is generated while drilling micro-holes in aircraft wings. Opteon™ and Vertrel™ are used as lubricants and heat transfer fluids during this process to prevent overheating and damage. Also, Opteon™ and Vertrel™ leave no residue behind.



Opteon™ and Vertrel™ specialty fluids are used extensively in the electronics industry to clean PCBs after soldering.

This is especially challenging because of a shift towards lead-free solders, which require higher temperatures and leave behind more-stubborn residue. Also, the demand for smaller electronics means more parts are packed on a single PCB. Tougher residue in smaller spaces makes today's PCBs more difficult to clean.

Opteon™ and Vertrel™ have risen to the demands of the electronics world and are the solvents of choice for electronics used in critical operations. Their low surface tensions allow Opteon™ and Vertrel™ to get through the tightest clearances, and their great solubilities ensure a suitably cleaned product.



Hard Disk

Opteon™ and Vertrel™ are the products of choice for cleaning and carrier fluid applications in the hard disk drive industry.

Disk Lubing

Every hard disk is coated with a lubricant that needs to be applied evenly and is critical to the performance of the disk. To achieve this, the lubricant is dissolved in Opteon™ or Vertrel™. Then, the uncoated disks are immersed in this solution and removed using a controlled process. Opteon™ and Vertrel™ evaporate rapidly to leave an even layer of lubricant on the disk, protecting against damage and loss of data.

Drive Assembly Cleaning

The drive assembly is a critical part of the hard disk drive. Any contamination in the assembly can damage the hard disk. To prevent this, these critical parts are cleaned using Opteon™ or Vertrel™.



Jewelry and Watchmaking

In the jewelry, watchmaking and lifestyle goods industry, the aesthetics of the product drives the purchase.

Because water-based detergents can leave spots behind, Opteon™ and Vertrel™ are used as both cleaning and rinsing agents, ensuring a spot-free product that is cool enough for immediate handling.

Opteon™ and Vertrel™ are also ideal for cleaning parts before plating and vapor deposition.

Medical Device



The superior performance of Opteon™ and Vertrel™ specialty fluids enables them to be used for a variety of applications in the medical industry.

Cleaning of Parts

The cleaning of medical devices is critical in preventing infection. The quality and performance of Opteon™ and Vertrel™ specialty fluids makes them the preferred choice of medical device manufacturers for this application.

Carrier Fluid

Needles and other devices are coated with a lubricant that enables easy entry into the body, reducing pain. Opteon™ and Vertrel™ are used to deposit these lubricants evenly in a process similar to that used in the hard disk drive industry. High quality and consistent performance make Opteon™ and Vertrel™ ideal for this application.

Opteon™ and Vertrel™ are also used to deposit silicones, as well as clean off the excess that may remain after deposition.



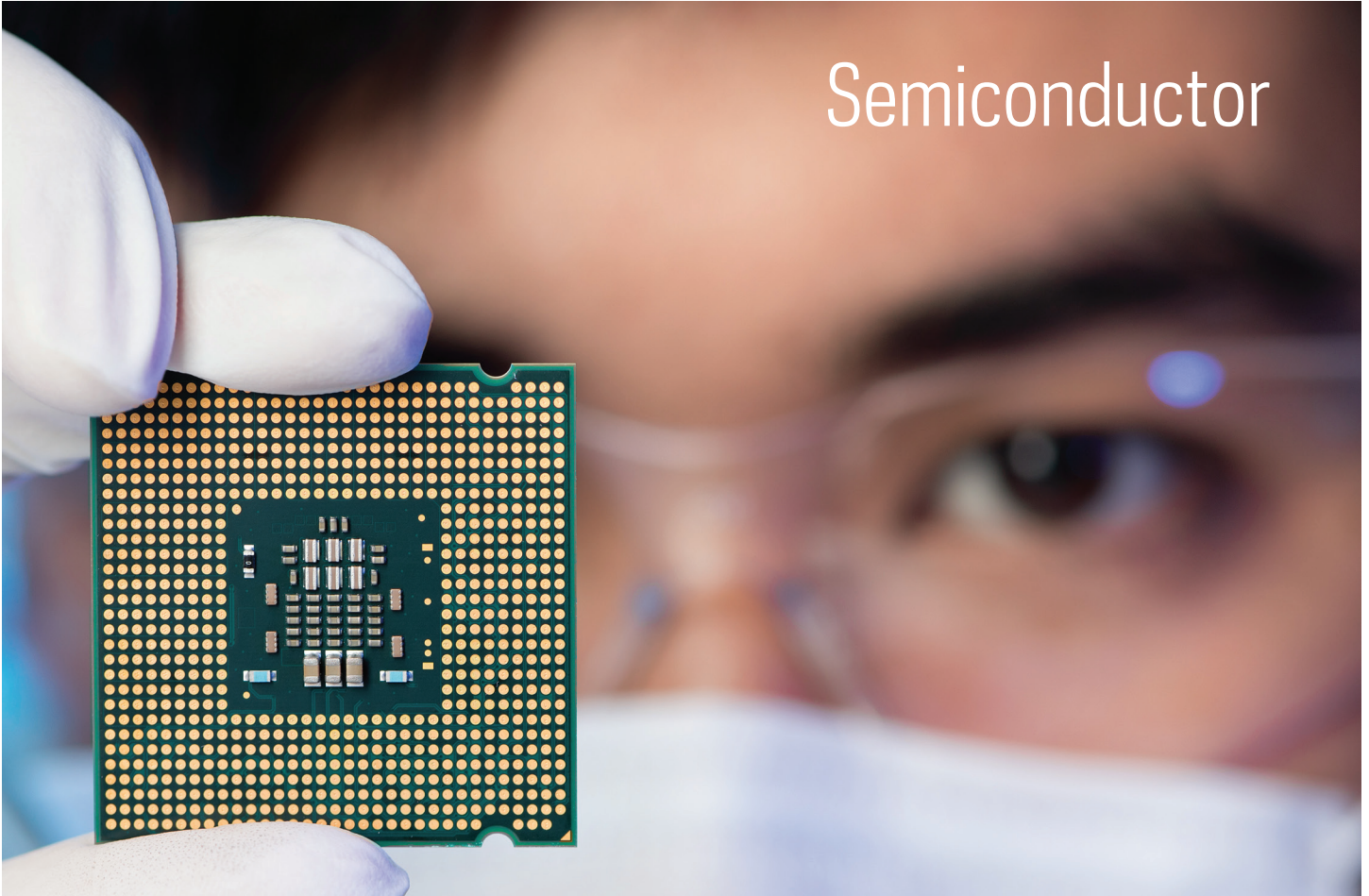
Opteon™ and Vertrel™ specialty fluids have superior performance that allows them to be used in a wide range of applications in the optics industry, such as optical assemblies, lens manufacturing, fiber optics and flat panel displays.

Cleaning and Drying

Opteon™ and Vertrel™ are used to ensure spot-free cleaning of optical parts, assemblies, displays and fiber optics. They are used during manufacturing and during the finishing process.

If water-based detergents are used to clean optical parts, there is often an issue of residue spots. Opteon™ and Vertrel™ are used as a final rinse step to ensure a spot-free finish for parts that must meet stringent performance criteria.

Semiconductor



Any product used in the semiconductor industry must meet stringent performance criteria; so, the exceptional performance of Opteon™ and Vertrel™ specialty fluids are ideal for a variety of semiconductor applications.

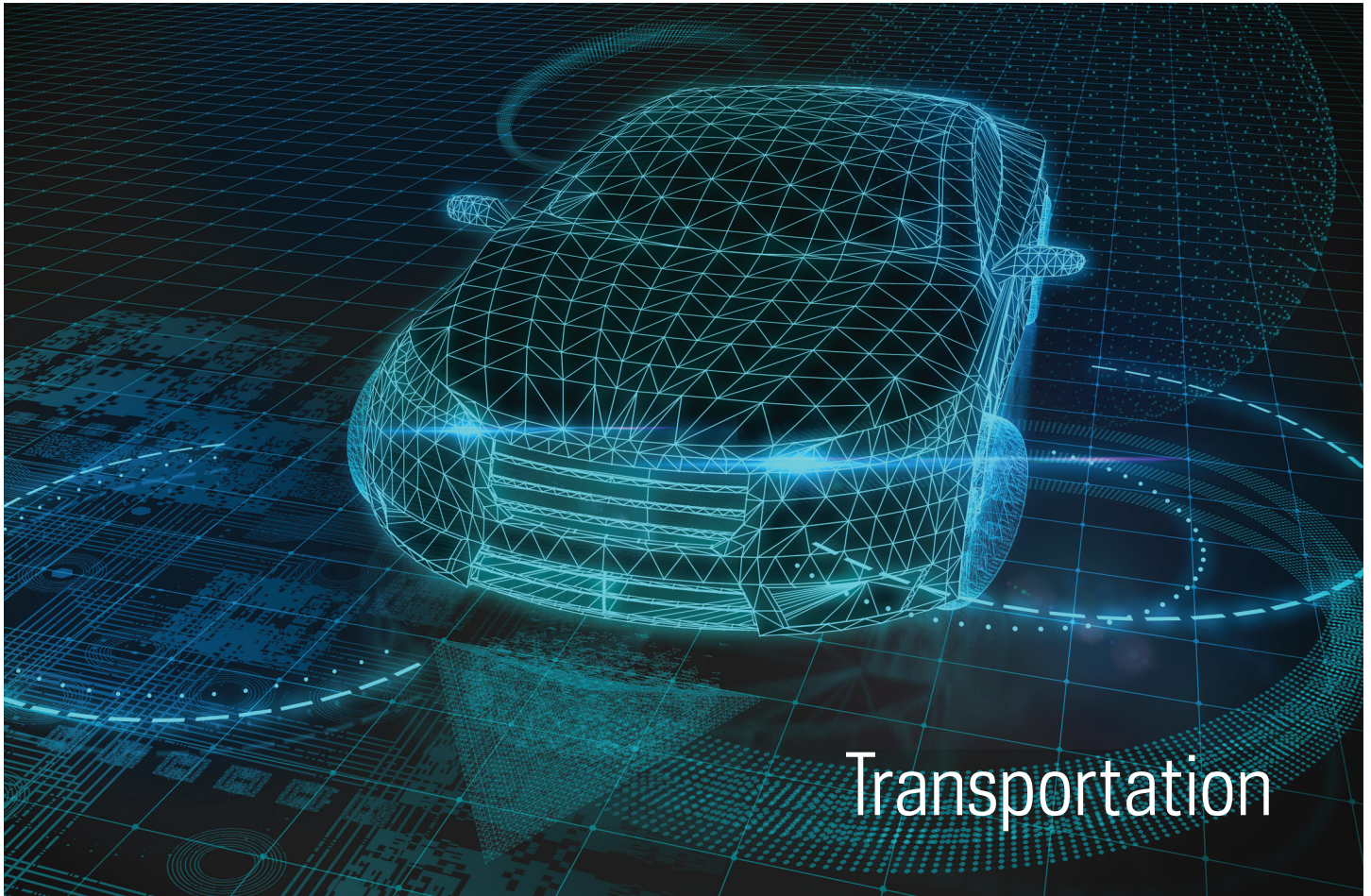
Cleaning

Due to their unique physical properties, Opteon™ and Vertrel™ specialty fluids are ideal for semiconductor manufacturing processes. Performance is critical to prevent contamination of front opening universal pods (FOUPs) that hold silicon wafers in controlled environments. Opteon™ and Vertrel™ specialty fluids are uniquely formulated for sub-micron CMOS particle removal and sensor cleaning applications.

Heat Transfer

Opteon™ and Vertrel™ are also used as heat transfer fluids in power semiconductors or IGBT modules in high-speed trains and elevator drives. Opteon™ and Vertrel™ provide consistent and reliable performance in these applications.

Opteon™ and Vertrel™ also provide superior cleaning and heat-transfer solutions for industries such as MEMS/NEMS.



In addition to the aerospace industry, Opteon™ and Vertrel™ specialty fluids are used in the automotive and railway industries.

Cleaning

Opteon™ and Vertrel™ are used extensively in the automotive industry to precision-clean critical parts for fuel injection, ABS brakes, compressors, relays, sensors and switches.

Carrier Fluid

Opteon™ and Vertrel™ are also used for the deposition of lubricants in the engine and passenger cabin, as well as coatings that improve the performance and properties on a variety of metal, plastic, glass and polymer substrates.

Heat Transfer

Opteon™ and Vertrel™ are used extensively as heat transfer fluids in the power modules of high-speed trains, enabling quick cool-down and consistent performance without breaking down.

Opteon™ and Vertrel™ Formulations and Their Applications

Opteon™ and Vertrel™ products are available in a variety of sizes. Based on the product, sizes range from 1 gallon poly bottles, to pails and drums, and bulk ISO containers.

Specialty Fluids	Typical Applications	Examples
Opteon™ SF10 Opteon™ SF33* Vertrel™ XF	Carrier fluid Rinsing media Grease removal Light soil cleaning Particulate removal Dielectric coolant Aerosol formulations	Various surface treatments Lubricant surface coating Drying systems with Vertrel™ XF or Opteon™ SF10 Krytox™ grease removal Electrical cabinet maintenance Hard disk drive cleaning HSA/HGA cleaning High-voltage systems Electronics industry Automotive industry
Opteon™ SF79 Opteon™ SF80 Vertrel™ MCA Vertrel™ SDG	Cleanliness verification Heavy and light soil cleaning Metal degreasing	Removal of nonvolatile residue Liquid oxygen system cleaning Vapor degreasing for heavier oils and greases in the automotive, aerospace and medical industries
Vertrel™ SMT Vertrel™ SFR	Defluxing	Defluxing of PCBs and hybrid circuits
Opteon™ SF01 Opteon™ SF05	Particulate removal Sub-micron particulate removal	CMOS cleaning Electronics sensor cleaning Precision optics

*Carrier fluid pending approval

Note that all Opteon™ and Vertrel™ products are not available in all regions.

Please contact the office closest to you to identify the best products available for your specific application.

Opteon™ | Vertrel™ Specialty Fluids Technical Comparison

The products within the specialty fluids portfolio provide a broad range of solvency power (kb value), materials compatibility and boiling points.

Property	Units	Opteon™ SF79*	Opteon™ SF10	Vertrel™ SDG	Vertrel™ MCA	Vertrel™ SFR	Vertrel™ SMT
Boiling Point	°C	47	110	43	39	41	37
Flash Point (TCC and TOC)	°C	None	None	None	None	None	None
Kauri-Butanol Value	kb	103	6	95	25	101	38
Vapor Pressure	kPa	44.7	2.9	51.7	61.8	57.9	64.75
Liquid Density	g/cm ³	1.29	1.58	1.29	1.41	1.28	1.37
Viscosity	cP	0.42	1.02	0.59	0.49	0.58	0.47
Surface Tension	Dyn/cm	21	18	21.2	15.2	19.9	15.5
Lower Flammability Limits (LEL)	% vol	7.25	None	7	None	7	7
Upper Flammability Limits (UEL)	% vol	15.25	None	14	None	15	15
Liquid Specific Heat	kJ/kg-°C	1.069	1.0	1.12	1.13	1.16	1.13
Heat of Vaporization	kJ/kg	280	115	283	181.2	285	207.1
Acceptable Exposure Limits (AEL)	ppm	201	500	193	200	187	192

Distributor Network for Opteon™ and Vertrel™ Specialty Fluids in North America

To make Opteon™ and Vertrel™ specialty fluids available to our customers locally, we have set up a distribution network that ensures our customers get prompt and local service. Information regarding our distribution partners by region and their contact information can be found at vertrel.com.

*Formerly Opteon™ Sion

For more information on Opteon™ | Vertrel™, please visit vertrel.com or call (800) 969-4758.

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