

**GFS CHEMICALS**

Innovative Chemical Technology  
For Innovative Applications



## **GFS CHEMICALS: ADAPTING CORE CHEMISTRIES TO CUSTOMER SPECIFICATIONS ACROSS THE PERIODIC TABLE SINCE 1928.**

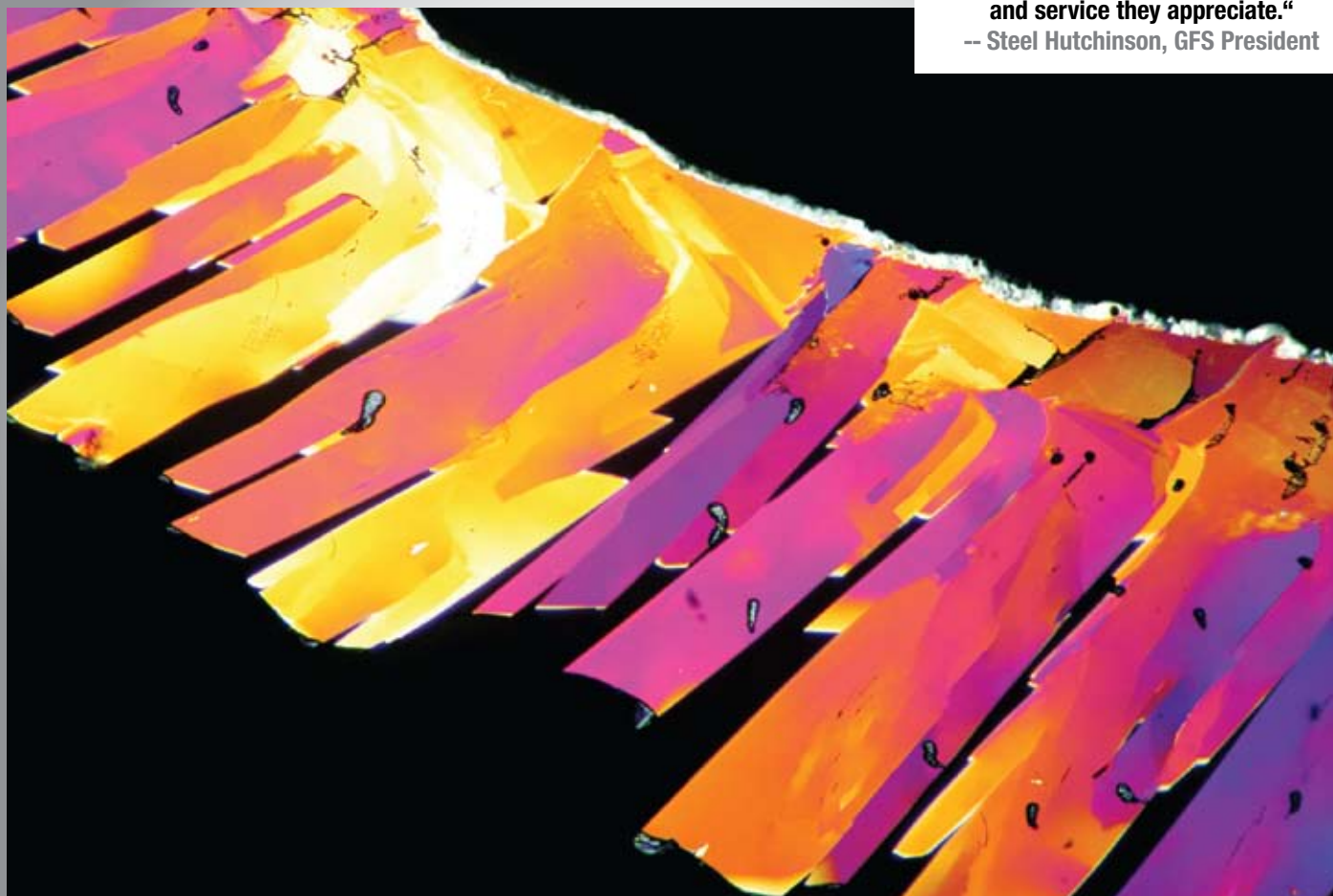
At GFS, chemists and technicians can connect to a single company with manufacturing resources in all key areas of chemistry.

Customers rely on us for our problem solving ability. Our proven technologies, technical expertise, engineering excellence and attention to detail allow us to work hand-in-hand with our customers every step of the way – from startup to commercialization.

GFS technology and products have kept us steps ahead of the industry's ever- changing chemical needs.

GFS Chemicals began when Professor G. Frederick Smith started producing perchloric acid in a small factory in Columbus, Ohio. Since then, GFS has grown to become a leading producer of specialty chemicals with performance-proven technologies for laboratory, analytical, scientific, research and development, pilot scale production, and manufacturing applications.

**“We’re big enough to do interesting chemistries for customers but small enough to do it with the flexibility and service they appreciate.”**  
-- Steel Hutchinson, GFS President



## GFS CORE BUSINESSES



Our company is divided into three core business units:

- Inorganic Chemicals
- Organic Chemicals
- Analytical & Laboratory Chemicals

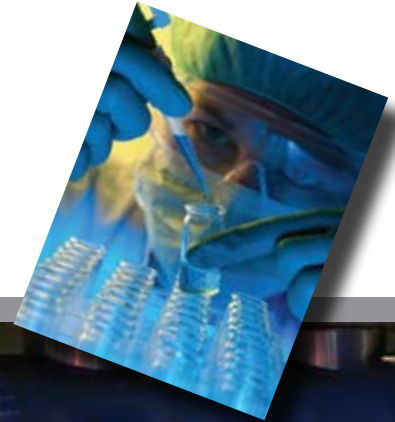
### **Performance-Proven Chemical Technologies for:**

- Advanced Energy Storage
- Agriculture
- Aerospace
- Alternative Energy
- Automotive Engineering
- Batteries
- Biotechnology
- Catalysts
- Environmental
- Government Projects
- Homeland Security & Defense
- Industry
- Life Sciences
- Manufacturing
- Medical
- Nanotechnology
- Optics
- Paints & Coatings
- Pharmaceuticals
- Petrochemicals
- Polymers
- Power Generation
- Research & Development
- Resins
- Semiconductors
- Superconductors
- University Research
- Water/Waste Water Technology

## INORGANIC CHEMICALS

Throughout the industry, we are recognized as “problem solvers” in the area of inorganic chemistry. We supply bulk quantities of inorganic products from multi-kilograms to ton lots, with special emphasis on quantities of one to ten metric tons. For scale-up projects we can supply many materials up to 100 metric tons through efficient batch production.

Using our proven technology to customize your product, we create customer-specific item numbers to streamline and safeguard your process. Our formalized and repeatable ISO manufacturing ensures that you get the same exact material every time.



**“Customers appreciate  
our flexible and experienced  
manufacturing team.”**  
-- Rob Pierron, Vice-President

## PERFORMANCE PROVEN GFS INORGANIC CHEMISTRIES

### RARE EARTH CHEMISTRY

GFS has extensive experience in manufacturing and sourcing the widest range of rare earth starting materials. Ultra-purity and ultra-dryness make GFS rare earth chemicals unmatched. We cover the majority of the Lanthanide series by offering rare earths ranging from ACS reagent grade through 99.99+ percent purity.

### CERIUM CHEMISTRY

GFS is primary in both Cerium III and IV chemistries. Some of the most demanding customers rely on GFS for their commercial applications.

### PERCHLORATE CHEMISTRY

GFS is the world's largest producer of perchloric acids and salts. Our perchlorate chemistry results in the manufacture of high purity perchlorates including: magnesium perchlorate, lithium perchlorate, potassium perchlorate and sodium perchlorate salts to name just a few.

### REDUCED MOISTURE PERCHLORATES

Our reduced-moisture perchlorates have a hygroscopic character that requires packaging in ampoules and handling in a rigorously dry environment. They can be used as catalysts in reactions that are only moderately sensitive to moisture.

### LITHIUM CHEMISTRY

GFS can supply many high purity lithium compounds, including lithium salts, lithium carbonate, lithium perchlorate and lithium iodide. Unlike some chemical manufacturers, GFS produces our lithium compounds from virgin lithium hydroxide – not from low-cost, low-quality lithium raw material residues. Purity levels for some GFS lithium products can exceed 99.99 percent.

### LITHIUM ION CHEMISTRY IN ORGANIC SYNTHESIS

Anhydrous  $\text{LiClO}_4$  in diethyl ether has an uncommon solubility. The concept of "naked ion"  $\text{Li}^+$  chemistries in organic media has broad synthetic implications. GFS can offer a valuable collection of reactions and references to novel synthetic schemes promoted by perchlorate salts. GFS offers a free 44-page monograph entitled Practical Use of Anhydrous  $\text{LiClO}_4$  and  $\text{Mg}(\text{ClO}_4)_2$  in Organic Synthesis.





**“GFS has a long history of being a quality organization. We have employees that have been part of GFS for up to 30 years.”**  
-- Dave Baust, Organics

## **ULTRA-HIGH PURITY ACID DISTILLATION AND SPECIALTY ACID MANUFACTURING**

Since 1956, through proprietary technology, GFS has perfected the distillation process to produce ultra-high purity acids to part-per-billion and part-per-trillion purity levels. We can supply nitric, hydrochloric, perchloric and sulfuric acids along with a host of trace metal grade acids. We supply some of the highest purity acids in the world today with virtually no trace contaminants whatsoever. Our iodic and periodic acid are unmatched in purity due to our unique manufacturing processes.

We also provide bulk packaging options for process applications requiring specific impurity profiles. Our expertise extends to the production of our reagent grade acids, which can be produced in metric tons and supplied in drums.

### **INORGANIC DRYING & PACKAGING**

Because of the refinement of our moisture control technologies, GFS has built a world-class reputation in the manufacture of anhydrous fine chemicals, specialty chemicals and temperature-sensitive chemicals. We have a state-of-the-art dedicated dry room for production and packaging, where constant dew point and humidity are maintained. Our drying technology will continue to evolve as customers challenge us with more specific anhydrous requirements.

## ORGANIC CHEMICALS

GFS is recognized as the world leader in the production of alkynes and downstream derivative technology. Using our core synthetic chemistries, we build upon our alkyne base to make thousands of specialty alkynes, olefins, silanes, halogenated organics, Grignards and heteroaromatics.

We can supply bulk quantities of organic products from multi-kilograms to ton lots, with special emphasis on quantities of one to ten metric tons.

### ALKYNES

Acetylene derivatives (alkynes) building blocks are the backbone of the GFS organic product line. We are a leader in the commercialization of specialty alkynes and derivatives.

### AMMONIA BORANE

GFS anticipates successful development of production quantities of very high quality ammonia borane for use as an alternative to common borohydride salts in both traditional and unusual organic reductions. We routinely manufacture ammonia borane with purity levels

near or above 99%, with hydrogen availability superior to  $\text{NaBH}_4$ . Material solubility properties offer alternative synthetic routes that store better and can be handled repeatedly without losing activity.

### HETEROAROMATICS

Classic heteroaromatic compounds including phenanthrolines, bipyridines, triazines and ligands are available from GFS. We can also provide parent compounds and metal complexes and derivatives.

### HALOGENATED COMPOUNDS

GFS has the capability to handle hydrogen chloride, iodine, bromine and other halogenating chemicals. The addition of liquid ammonia chemistry and Grignard chemistry further expanded our capabilities. We sell a wide range of halogenated alkynes, alkenes (olefins), alkanes, cyclic and heteroaromatic compounds, and organohalides.

### LIQUID AMMONIA CHEMISTRY

GFS is the market leader in the development and production of liquid ammonia chemistries and acetylenic and olefinic specialties. Our liquid ammonia technologies enable the synthesis of long chain olefinic pheromones and precursors.

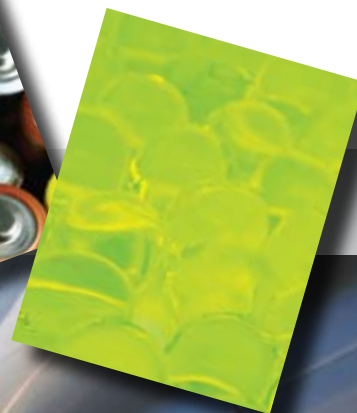
### OLEFINS

GFS is the single supplier for many olefins (ENEs) on the market today. We can supply various olefins of geometric specificity (cis or trans), and we supply individual isomers of many olefins. Our customers benefit from our vertical integration in this area.

### GRIGNARD CHEMISTRY

GFS offers specialty Grignards. Our plant capacity supports Grignards from lab scale through container loads including organometallic, vinyl, alkynyl, aryl and alkyl Grignards. Typically, our Grignard products are made on demand and available in bulk or in cylinders.

Visit [gfsorganics.com](http://gfsorganics.com) for more information on our organic technologies.



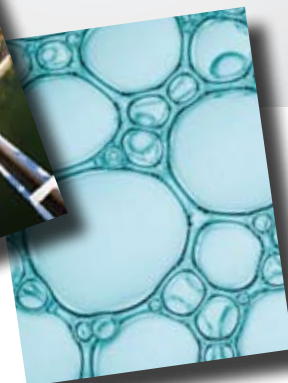
## ANALYTICAL & LABORATORY CHEMICALS

Many process applications begin with the trial of our catalog sizes. Specific details on these products can be found in our comprehensive catalog.

GFS manufactures over 6,000 organic and inorganic analytical reagent chemicals and specialties in a lean manufacturing operation. We have most chemicals needed for laboratory, bench, analytical, quality control, materials characterization, scientific or research work.

Our ultra-high purity double-distilled Veritas<sup>®</sup> and ACS Superior<sup>™</sup> brand acids and Watermark<sup>®</sup> brand reagents are used throughout the world. GFS In-Spec<sup>®</sup> chemicals set the standard for spectrophotometry calibration. Our AMCO Clear<sup>®</sup> Water Analysis Division manufactures the highest water calibration standards available for water treatment plants around the globe.

- Watermark<sup>®</sup> Pyridine-Free Karl Fischer Reagents
- Veritas<sup>®</sup> HPLC Solvents
- HPLC/GC/UV-Vis Solvents
- Reagent Grade Solvents
- Spectroscopy Products
- In-Spec<sup>®</sup> Spectrophotometric Standards (TOC, UV-Vis, SUVA-254, Colorimeter)
- AMCO Clear<sup>®</sup> Turbidity Standards
- Primary Standard Salts
- Normality Solutions
- Dyes and Indicators
- Silver Compounds
- Reagents for Water & Wastewater Labs
- Organic Halogen Reagent – OHR/Halogen Level Field Test Kits
- Polyethylene Glycol (small quantities)
- Conductivity Standards and pH Buffers
- AA and ICP Standard Solutions
- Anion Standard Solutions
- Standard Solutions for Trace Metal Analysis
- ACS Reagents
- ASTM Type I Deionized water







**“Our company culture is based on truth and integrity. And our people deliver on the service promise.”**

**-- Harry Ruska, GM**

## **MANUFACTURING**

Product performance starts with manufacturing. Our state-of-the-art production facilities in Columbus, Ohio, coupled with our innovative manufacturing expertise, allow us to produce the quantity of superior-quality chemicals that you need.

Whether your procedures or processes call for liters, grams, kilograms or metric tons, GFS can deliver the exact quantity of chemical you need— on time, just-in-time, every time.

## **PACKAGING**

Whether you're buying grams or metric tons, your product can be packaged to your specifications — drums, cylinders, bags, boxes, pails or totes.

## **DRYING**

GFS Chemicals has built a world-class reputation in the manufacture of anhydrous materials for decades through continuous refinement of moisture control technologies. Our proprietary in-house drying methods have led to the development of numerous value-added anhydrous chemicals for electronics, battery, pharmaceutical and specialty applications.

## **PROJECT CUSTOMIZATION**

Our production environment gives us the flexibility to offer you innovative solutions for all of your chemical needs. GFS research and development can support you with the chemicals that your application requires.

Using our proven technology to customize your product, we create customer-specific item numbers and SKUs to streamline and safeguard your process. Our formalized and repeatable ISO manufacturing ensures that you get the same exact material every time. We package according to your requirements in small packages through drums.

If your application requires more stringent conditions, we have experience with Good Manufacturing Practice (GMP) processes. We are a key supplier of critical materials for numerous Fortune 100, GMP manufacturers. We understand the needs of our GMP customers — including pharmaceutical manufacturers.



**“That’s the key to what we do.  
We really try to understand exactly  
what the customer is looking for.”**  
– Marty Kiser, CFO

#### **UNMATCHED PRODUCT QUALITY**

GFS is an ISO 9001-2008 certified company. Our quality control team guarantees product consistency from lot to lot. We guarantee our products to meet the quality standards that we publish, and ship a Certificate of Analysis and a Material Safety Data Sheet (MSDS) with every order.

#### **ENVIRONMENTAL & COMMUNITY STEWARDSHIP**

GFS was founded on a business philosophy of community stewardship and respect for our environmental resources. As a long-standing member of the Society of Chemical Manufacturers & Affiliates (SOCMA) and the Ohio Chemistry Technology Council, GFS is committed to conducting our business with integrity and foresight. In addition, GFS is committed to full implementation of the SOCMA ChemStewards environmental, health, safety and security management system.

#### **TECHNICAL SUPPORT**

We back up every product we sell with technical support that is unmatched in the industry. Our technical support team is ready to interact and answer your product questions.

#### **CUSTOMER SERVICE**

We believe the personal human element makes a difference in today’s “electronic age.” That’s why GFS customers know they will always be able to connect with a live customer service representative.



## WHY CHOOSE GFS?

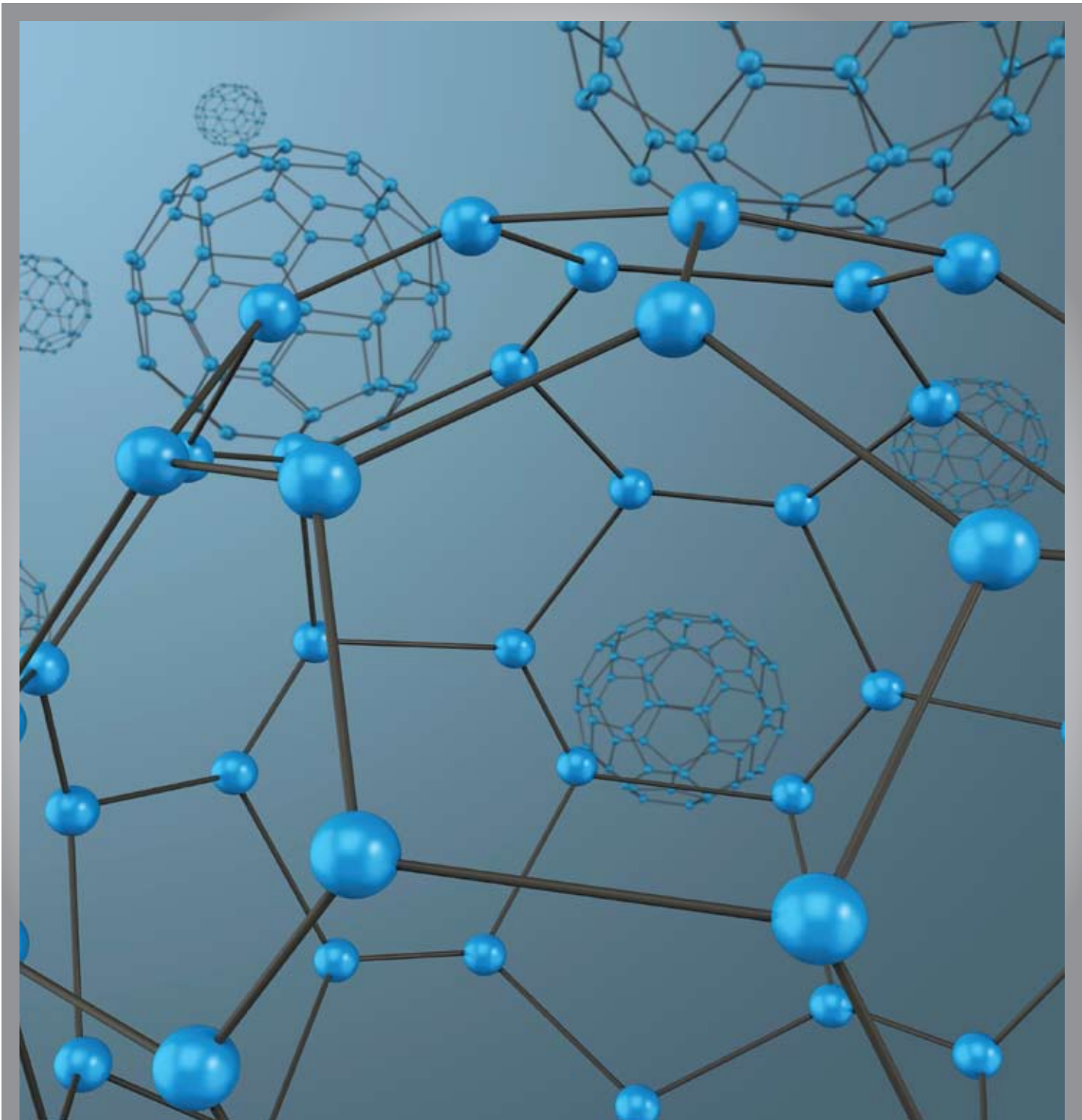
- 80+ years of chemical manufacturing and chemistry experience supporting process and commercial applications
- Knowledgeable chemists and operators who have a complete understanding of the manufacturing process
- Scale-up flexibility from small sample sizes to drums to metric tons, to ensure consistent quality from R&D to pilot to final production
- International expertise shipping products to 85+ countries means your products will arrive on time, meeting all regulatory compliance regulations
- Technical support and resources every step of the way
- Dedicated, responsive customer support personnel and points of contact
- Competitive pricing and reliable production lead times
- U.S.-based quality manufacturing to ensure material availability, consistency and delivery
- Experienced staff who understand the complexities and dependencies of process chemistry

**Contact us regarding your specialty or process application. We promise to exceed your expectations for innovative chemical technology solutions.**



**“One of the great things about our quality control lab is the access to the state-of-the-art equipment we have.”**

**-- Robert Kramer, QC Manager**



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