





Providing Materials Solutions
Molecules to Manufacturing™



ABOUT

Since 2001, Tetramer has provided research, development, and manufacturing of advanced materials and specialty chemicals. With backgrounds in organic, physical, polymer, and analytical chemistry, ceramic engineering, materials science, and chemical engineering, our scientists' expertise in materials design, synthesis, analytics, and scale-up allows us to address a broad range of technical and market challenges.

SERVICES

Our customers desire product differentiation through superior materials. Our team of scientists and engineers excel in materials research and development (TRL 1-6), but we are differentiated by our ability to scale up (TRL 7-8) and manufacture (TRL 9) proprietary advanced materials for our customers.



Tetramer has the team and infrastructure in place to accelerate materials development and commercialization across all stages of the development lifecycle.

**Materials Development
Manufacturing**

**Investigative Analytical Services
Technology Assessment**



From low fat chocolate to laser weapons systems, Tetramer Molecular Architects work across a broad range of applications.

APPROACH

Our highly skilled chemists, engineers, and scientists work to create open clear communication of complex research challenges with our partners. We design and synthesize compounds with the molecular structures needed to provide desired properties which solve your problems. Our goal is to help our partners succeed by advancing materials technologies into the marketplace through a fundamental understanding of chemistry and business.

PARTNERS

Tetramer works with our partners to develop market-driven materials and transition those materials from the lab to the market. From Molecules to Manufacturing, Tetramer supports our partners across every stage of the innovation process.

Our customers range from small business startups to global companies, with projects spanning diverse industries and markets. With extensive R&D and manufacturing capabilities, Tetramer can serve as both a research partner and a vendor supplying developed materials. We have the flexibility to tailor development contracts and nondisclosure agreements to fit the needs of individual relationship.



We've had an extraordinarily productive, creative collaboration with Tetramer that began 10 years ago with dormant technology. Together, we've overcome obstacles, broadened and deepened the science supporting our breakthrough food concept, and now we get to see these products on store shelves.

David Rowe | Founder and CTO | Epogee

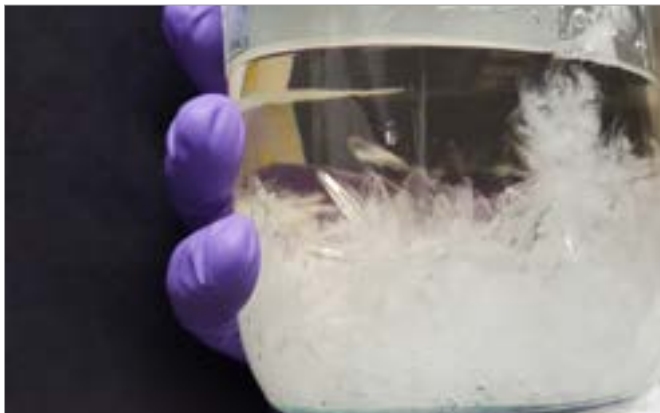


SERVICES DETAIL

MATERIALS DEVELOPMENT

Molecular level research and development delivers enabling materials to diverse markets.

- Monomer, Polymer, and Nanocomposite Development
- Coatings/Adhesives
- Biorenewable Materials
- Formulations Development



TECHNOLOGY VALIDATION AND TRANSITION ASSESSMENTS

Tetramer analyzes factors required to transition a new material from the lab to the marketplace, providing the customer with a comprehensive risk profile associated with each aspect of the transition process. Customers include universities, industrial open innovation groups, government agencies, and venture capital groups.

- Chemistry
- Scale-up
- Supply Chain
- Regulatory
- Cost Analysis & Manufacturing Sensitivity



INVESTIGATIVE ANALYTICAL

With access to analytical equipment in-house, Tetramer provides custom, investigative analytical support to meet a variety of customer needs. Tetramer's strong background in materials R&D and process research provides a unique capability in comprehensive analytical support for materials and processes.

- Full analytical lab staffed by analytical chemists
- Root Cause Analysis
- Deformulation
- Quality Evaluations



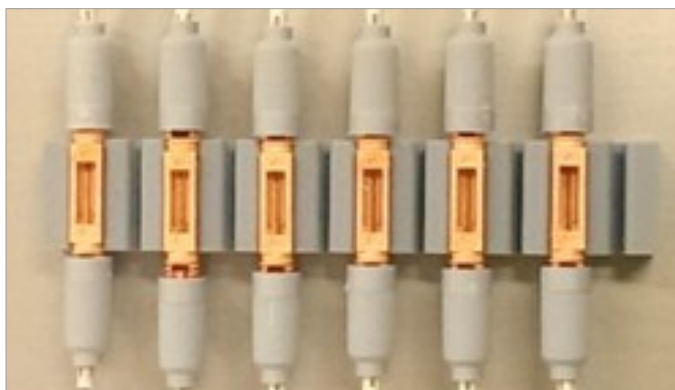
SPECIALTY MANUFACTURING

Developing technical transfer packages for scale up, Tetramer can custom manufacture specialty monomers, polymers, and resins and oversee larger toll manufacturing processes.

- In-house Manufacturing
- Secure Supply Chains
- ISO 9001:2015



TETRAMER PRODUCTS



TIMA™ UV-CURABLE FIBER OPTIC ADHESIVES

Robust, easy-to-use adhesive for repairs in the field



TETRIMIDE™ POLYIMIDE COATINGS

High-temperature, custom-color coatings for wire, fiber optic, and cable



EPOGEE™ LOW CALORIE FAT REPLACER

Low calorie fat replacer co-developed with Epogee and now sold in a variety of food products



PERFLUOROCYCLOBUTYL IONOMERS

Tailorable polymer for gas separation, water vapor, or proton exchange membranes



VBASE OIL COMPANY

A Tetramer company, VBASE Oil Co. offers high performance base oils in a range of viscosity grades (ISO 32-460) that are biobased, biodegradable, non-toxic, and non-bioaccumulating. This New Class of High-Performance Synthetic Esters exhibits superior high temperature and hydrolytic stability with exceptional cold weather performance.

www.tetramer.com

MOLECULES TO MANUFACTURING

Core Competencies

Advanced Chemical Synthesis
Design of Functional Materials
Structure Property Relationships
Analytical Characterization

Joint Product Development
Process Research and Scale-Up
EHS and Regulatory Filing
Supply Chain

FACILITIES

Tetramer's 18,000 ft² facility houses over 6,500 ft² wet lab space furnished with 20 chemical hoods, fully-equipped reactors ranging from 1 to 150 liters, a Class 1000 cleanroom, environmental chambers, and much more.

Our on-site Analytical Lab is staffed by full time analytical chemists and provides chemical, electrical, optical, and thermomechanical characterization with access to an electron microscopy facility.



NIST 800-171 and CMMC
Level 3 Security Program

DCAA Approved
Accounting System

Full-Time Security Officer

ISO 9001:2015 Quality



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TETRAMER[®] ANALYTICAL SERVICES

Having a problem with a material? Whether you are trying to understand a failure mechanism in an adhesive, why a coating is blistering, or how to better characterize a material for patent protection, we can help.

We provide custom, investigative analytical support through root cause analyses, deformation studies, process characterization, and quality evaluations. Our onsite analytical laboratory includes an in-house support network of PhD and MS Analytical and Organic Chemists and Material Scientists. Our background in Materials R&D and Process Research provides a unique capability for analysis of materials throughout the value chain.

INVESTIGATIVE ANALYSIS

We provide in-depth characterization of materials, products, and processing. In addition to a broad range of analytical instrumentation and characterization equipment, our team has a deep understanding of synthetic organic chemistry, ceramic and chemical engineering, optical materials, paints and coatings, adhesives, advanced membrane technologies, materials science, solid state physics, and more that enables the study of unique materials challenges.



WE BRING CLARITY TO YOUR COMPLEX MATERIALS AND PROCESSING CHALLENGES.

Root Cause Analysis

Deformation Study

Process Characterization

Quality Evaluation



COOPERATIVE APPROACH

Our team works to form interactive relationships with customers to develop a complete understanding of their technical challenges. This cooperative approach enables a thorough identification of factors affecting customers' materials and helps us to develop effective strategies for improving the reliability and profitability of their products.

Materials often require innovative approaches to identify and characterize technical issues. Tetramer can develop outside-the-box analytical methods to provide more complete and meaningful data sets for problem solving.



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CUSTOMER FEEDBACK

"I have to say you [Tetramer] are more responsive than any other "lab"/research organization that I have dealt with; that is highly appreciated."

Senior Materials Engineer | Tier 1 DOD Supplier

"There are many companies that have technical test capabilities and expensive machines but can't follow through to help educate a customer through a transparent exchange of ideas. I think this really sets your team apart from other companies we've worked with. I've found the recent project interesting, engaging, and quite honestly, a fun learning experience."

John Earl | Director of Engineering | Techtronic Industries 

FACILITIES & CAPABILITIES

Tetramer's facilities, located in Anderson County near Clemson, SC, include more than 7000 ft² of laboratory space furnished with 20 chemical hoods, fully-equipped reactors, a Class 1000 clean room, environmental test chambers, as well as established access to additional capabilities at nearby Clemson University.

Tetramer's comprehensive in-house analytical laboratory is staffed by full-time analytical chemists. Our depth of instrumentation enables high through-put of analytical testing. This results in quick turn-around times for analyses and the ability to provide customers with rapid feedback on time-sensitive projects.

CHEMICAL/PHYSICAL CHARACTERIZATION

- Chromatography (HPLC, GPC, GC)
- Rheology
- Universal Mechanical Testing (Instron)
- Particle Size Analysis (DLS)
- Gas Permeation Testing
- X-Ray Diffraction



THERMOMECHANICAL ANALYSIS

- Thermogravimetric Analysis
- Differential Scanning Calorimetry
- Thermomechanical Analysis
- Dynamic Mechanical Analysis

OPTICAL CHARACTERIZATION

- Vibrational Spectroscopy (UV-Vis, FTIR)
- Fluorescence Spectroscopy
- Abbe Refractometry

METHOD DEVELOPMENT

- Polymer Characterization
- Accelerated Aging
- Deformulation

MICROSCOPY

- Optical
- Cross-Polarized
- SEM / TEM / EDS / FIB / XPS



TETRAMER ANALYTICAL EQUIPMENT AND CAPABILITIES

Equipment

Reactors

450 L SS Jacketed Reactor
150 L SS Jacketed Reactor
50 L Glass (mantle & jacketed)
Multiple 22 L Glass (mantle & jacketed)
Multiple 10 L Glass (mantle & jacketed)

Processing Equipment

Roto-evaporators
Short Path Distillation
Wiped Film Evaporators
Centri-vaps
Vacuum ovens
Muffle furnaces
Tube furnace
High shear mixers
Thinky® planetary mixers
6L centrifuge

Analytical Capabilities

Chromatography

- GC Systems (2) – Agilent 7890A GC with 8-position autosampler and Agilent 7820A GC with 50-position autosampler, Agilent 7694 Head space analyzer with 50 positions
- HPLC/GPC– Agilent 1260 Infinity System with a RI detector, 1260 VWD, Chem station software and Cirrus GPC software
- GPC– Agilent 1260 Infinity System with a RI detector, Chem station software and Cirrus GPC software
- Automated Titrators – Mettler Toledo AQV33 Karl Fisher volumetric and C20 coulometric titrator
- Flash Chromatography – Teledyne Isco Combi Flash Companion Flash Chromatograph

Thermal Analysis

- TGA (2) – TA Instruments Q500 capable of up to 1000 °C
- DSC - TA DSC 2920 (-30 °C to 350°C)
- DSC – TA Q2000 (-90 °C to 700°C)
- DSC – Perkin Elmer Pyris Diamond DSC with Photo-DSC capability
- TMA – Perkin Elmer Pyris Diamond TMA (-150 to 600 °C)
- DMA – EXSTAR 6000 SII (-150 to 600 °C)
- Dropping Point System – Mettler Toledo DP90
- Rheometer – Brookfield R/S plus cone and plate Rheometer
- Rheometer – Brookfield DV-III Ultra
- Presto Melt flow Index Dx
- Kinematic viscosity

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Spectroscopy

- FTIR – Bruker tensor 27 Diamond window ATR-FTIR
- UV-Vis Spectroscopy – Dual Beam UV/Vis with spectral range 190 -1100 nm
- Fluorescent Spectroscopy – Perkin Elmer Spectrometer with 4-position, computer-controlled sample stage for excitation/emission scans
- AAS – Thermo Elemental AA series spectrometer (Cu, Fe, Ni, As)

Physical Testing/Sample Prep

- Density – AccuPyc 1330 Helium Pycnometer
- Needle penetration – Scientific Petroleum Instruments Precision Penetrator
- Shore -D hardness tester
- Gardner Liquid color standards
- Wafering Saw – Pico155 Precision cutter
- Grinder-Polisher – MetaServ 250
- Contact Angle Analyzer – FTA 125
- Instron – 5500R series (Load cells 2KN to 150 KN)
- Water vapor transport membrane testing unit – Custom built by GM
- Refractometer – ABBE Mark II
- Mitutoyo Thickness gauges
- Particle Size Analyzer – LS 13320 Beckman Coulter laser diffraction particle size analyzer
- Micromeritics NanoPlus HD laser diffraction particle size analyzer
- Plasma System – MARCH Instruments Incorporated PM-600
- Nano composite deposition system – Custom-made
- UV curing source – DyMax Blue wave
- Vacuum Sealer – Original Henkelman Lynx 32 (with inert capability)
- MINOLTA CR-14 colorimeter
- MTI Spin Coater
- UVC 500 UV cross linker
- Thin film casting (50 sq ft Class 100 Clean room and film casting table)
- Electrospray deposition (Powder coating)
- Heat press – RUCKER PHI (up to 200 °C, 30 tons)
- Pellet press – CARVER 4350L (Clamping force 11 Tons)
- Thermal Vacuum Metal Deposition (LADD)
- Gardner Scrub Abrasion Tester
- Elcometer 108 Digital Hydraulic Adhesion Tester: 0-3500 psi
- Elcometer 1542 Cross Hatch Tester: 1, 2, & 3mm cutter
- Instron Lapshear Testing
- ASTM D 1654, 610, 3359, 4541 Analyses
- Radiant Technologies LC Meter
- Oscilloscopes
- Kiethley Electrometer
- 100 kV DC Power Supply, 5 kV SRS Power Supply

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- 3 Gas Membrane Permeation Systems ($O_2, N_2, H_2, CH_4, CO_2$)
- Intrinsic Gas Permeation Characterization System (gas solubility and diffusion)

Environmental Testing

- Incubator – Caro 6010 Binder (5 to 60 °C)
- Environmental chambers (3) – Sun systems (-100 to 300 °C)
- Environmental Chamber –THERMOTRON SM-8C (-60 to 180 °C, Humidity 10-95 %RH)

Chemical Analysis

- Acid Base Titrators (2) – Metrohm 809 Titrando and 848 Titrino Plus
 - Acid value, Saponification value, Iodine value, Peroxide value, Hydroxide value, Amine value, Oxirane value determination capabilities
- pH meters

Microscopy

- AmScope digital capture trinocular microscope
- Zeiss Axioplan Microscope with cross polarization capability and AmScope digital microscopy
- Fiber Endoscope

Synthetic Capabilities

- Custom monomer and polymer synthesis up to 22 L scale in glass and up to 150 L stainless reactor
- Functionalization of PFCB polymers
- Monomer and polymer purification (Flash Chromatography, crystallization)
- Rotatory evaporation
- Esterification from 2Kg to 12 Kg
- Steam deodorization
- Pressure filtration
- Oil bleaching
- Wiped film evaporation
- Food product development
- Organic and organometallic synthesis
- Stereoselective reactions
- Catalysis and coupling reactions
- Metathesis
- Fluorinated materials
- Schlenk techniques, air-sensitive materials, gas reactions, pressure reactors
- Polymer additives
- Natural oil derivatives
- Specialty waxes and formulations

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- Personal care ingredients
- Emulsions and surfactants
- Base oil fluids and additives
- Synthesis optimizations
- Applications testing
- Film casting (Clean room)
- Adhesion testing (dolly and tape)
- Resins and Coatings
- Surfactants/formulation testing
- Step growth polymerization (Polyesters, polyurethanes)
- Radical polymerization
- Polymer (acrylic/styrene/polyimide) synthesis up to 22L
- Metathesis/esterification scale up to 1 Gal
- Nanoparticle Synthesis (QDs, Rare-Earth, metal, ceramic)
- Ligand Synthesis
- Reactive materials
- Latexes
- Nano composite coatings
- Hydrophobic and oleophobic coating

Clemson University Analytical Capabilities:

- NMR - 500 MHz (liquid/solid), 300 MHz (Liquid) NMRs
- Electron Microscopy – AFM, SEM, TEM (300 kV, 120 kV), EDS, XPS, e-beam lithography equipment, dual-beam SEM/Focused Ion Beam
- GC-MS
- ICP
- MALDI, EI/CI-MS
- TGA-MS, TGA-FTIR
- X-ray Fluorescence
- ASI react-IR, UV-Vis-NIR, Raman, Fluorescence Spectrophotometers
- Powder and thin film X-ray diffractometers, single crystal 18 kW rotating anode, and single crystal CCD detector X-ray diffractometers
- Surface analysis, Porosimetry, Variable Humidity Conductivity Meter
- DSC, DMA, DETA, DMS, and other rheology equipment
- Hot-stage microscopes, fiber spinning equipment, mini extruders, dynamic dielectric analysis, conductivity probes, and various Instron models for physical testing
- Elemental analysis