

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 -1300 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 gauge
- 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 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
- Analyze samples in accordance with ASTM D 1654, 610, 3359, 4541
- 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 (O₂,N₂,H₂,CH₄,CO₂)
- 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
- Nanoparticles (QDs, Rare-Earth, metal, ceramic)
- Ligands
- Reactive materials
- Latexes
- Nano composite coating
- 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