CPAC Brochure June, 2016

THERMAL, MECHANICAL & RHEOLOGICAL CHARACTERIZATION OF POLYMERS

Differential Scanning Calorimetry (DSC)

Determines characteristics, such as degradation temperature, absorbed moisture content, level of inorganic and organic components, decomposition points of explosives and solvent residue of polymers and other materials.

TA Instruments Q2000

. Operating range: -70ºC to 350°C
. Equipped with both modulated and high-resolution capability.

Thermal Gravimetric Analysis (TGA)

Used to determine characteristics of materials, such as polymers, to determine degradation temperatures, absorbed moisture content, levels of inorganic and organic components, decomposition points of explosives and solvent residue.

TA Instruments Q500

. Operating range: Room temperature to 950°C
. Equipped with multiple gas inputs for testing under both pure thermal and oxidative degradation modes.

Dynamic Mechanical Analysis (DMA)

Dynamic Mechanical Analysis provides information that can be Measures thermomechanical properties of a polymer, such as glass transition, modulus, viscosity, softening temperature, gelation, degree of cure and impact resistance.

TA Instruments RSA III

. Strain controlled
. Temperature range: -150°C to 500°C
. Maximum force: 35 N
. Three point bending used to flex solid samples. Tension used to test thin films.
. Equipped with parallel plate.

Seiko EXSTAR 6000 (DMS)

. Stress controlled
. Temperature range: -150°C to 500°C
. Maximum load: ± 5N
. Elasticity measurement range:
. Young's Modulus (Bending) $1x10^{5}$~10^{12} Pa
. Rigidity Modulus (Shear) $1x10^{3}$~108 Pa

Rheology

Characterizes the viscoelastic behavior of polymers and polymer solutions, such as viscosity, both steady and complex, as well as steady and complex storage and

loss modulus, damping factors, flow index, melt index and yield point.

TA Instruments AR G2

. Stress controlled rheometer
. Operating range: -160ºC to 600ºC
. Equipped with air bearing gas pressure system (air or nitrogen), ultra-low, nano-torque control with minimum torque oscillation resolution of 0.003 µN.m, and can be equipped with ETC camera viewer to visualize material behavior.

HAAKE Rheo Stress

. Strain controlled rheometer
. Operating range: -140°C to 200°C

Universal Testing

Measures the mechanical strength of materials in tension compression and bending modes. Both frames have clamps for three point, fiber, yarn, wire and fabric, as well as standard tensile bars.

Instron Model 4505

. Equipped with environmental chamber: -100 ºC to 100 ºC
. Load cells to 20,000 lbs

Instron Model 5500

. Load cells to 1,000 lbs

Impact Testing

Measures the impact load and energy required to puncture or break materials. Can also provide information on the type of failure mode for both brittle and ductile failure.

Instron Model 8250

. Applied load up to 3,500 lbs

STRUCTURAL & CHEMICAL CHARACTERIZATION

Particle Sizing

Measures particle size in colloidal suspensions.

Nicomp 380/zls&s

Equipped with 35 mw laser diode, an avalanche photodiode detector for sizing and a second detector for zeta potential. Includes a goneometer platform for multi-angle detection and autodilution.

GPC

Viscotek 300 TDA

Obtains polymer structural information, such as molecular weight, molecular size

(radius of gyration, Rg), conformation, branching, copolymer composition and aggregation. Equipped with a refractometer, viscometer, and light scattering.

Atomic Force Microscope (AFM) — Veeco Dimension 3100

Measures surface properties on the nanoscale, nanoroughness and local distributions in modulus.

Automated Capillary Flow Porometer — Porous Materials, Inc.

Measures pore-size distribution, mean flow pore diameter, pressure hold, gas permeability and bubble point (maximum through pore diameter). Pore size from 0.03 Micron to 80 Micron.

GC/MS Instrument, G 300 — Griffin Analytical Technologies, LLC

Measures elemental composition of a sample or molecule and for elucidating the chemical structures of molecules, such as peptides and other chemical compounds.

. Operating range: 10ºC to 30ºC, relative humidity less than 85 percent
. Mass range of 10-35, 35-425 amu.

FTIR Units

FTIR detects molecular groups and provides chemical identification of polymers, including copolymer content. Raman measurements can provide details on surface chemistry and local environment.

FTIR – Nicolet 6700

Equipped with both transmission and ATR sampling geometries. Also equipped with Raman NXR-FT Module.

FTIR – Perkin Elmer 2000

Equipped with transmission.

Additional Testing Capabilities

. UV-Vis Spectrophotometer Measures concentration of solutions and identify UV absorbing compounds. Wavelength range: 190-1095 nm.
. CSI-135 Gas Permeability Tester Measures volumetric gas permeation rate through materials (film, membrane) as a function of pressure per ASTM D1434. Temperature range: 0 - 100 ºC
. Dynamic contact angle analyzer
. Thermal conductivity: ALAMBETA thermal conductivity tester and a DYNAFIL-M
. Dimensional properties: AFIS, HVI, VIBROSCOPE
. Mechanical properties: TENSORAPID, FAFEGRAPH, ELMENDORF tear, MULLEN burst tester, bending length and circular bending, mit folding endurance tester
. Abrasion resistance: TABER rotary abrader, SCHIEFER uniform, universal FLEX

. WEAR tester, DURANT carpet abrader, ZWEIGLE abrasion tester, SULZER RÜTI abrasion tester
. Permeability testing: FRAZIER, GURLEY, CSI, LYSSY

Sample Preparation and Pilot Scale Production Capabilities

. Injection molder: 50-ton clamp force with 100 ml shot maximum shot size, full electric operation
. Wayne extrusion line: monofilament and multi-filament capabilities and a 6-inch film die
. 18 mm Liestritz twin screw extruder equipped vaccum vents and single strand die. Can be configured in either co- and counter-rotation mode and with side stuffer