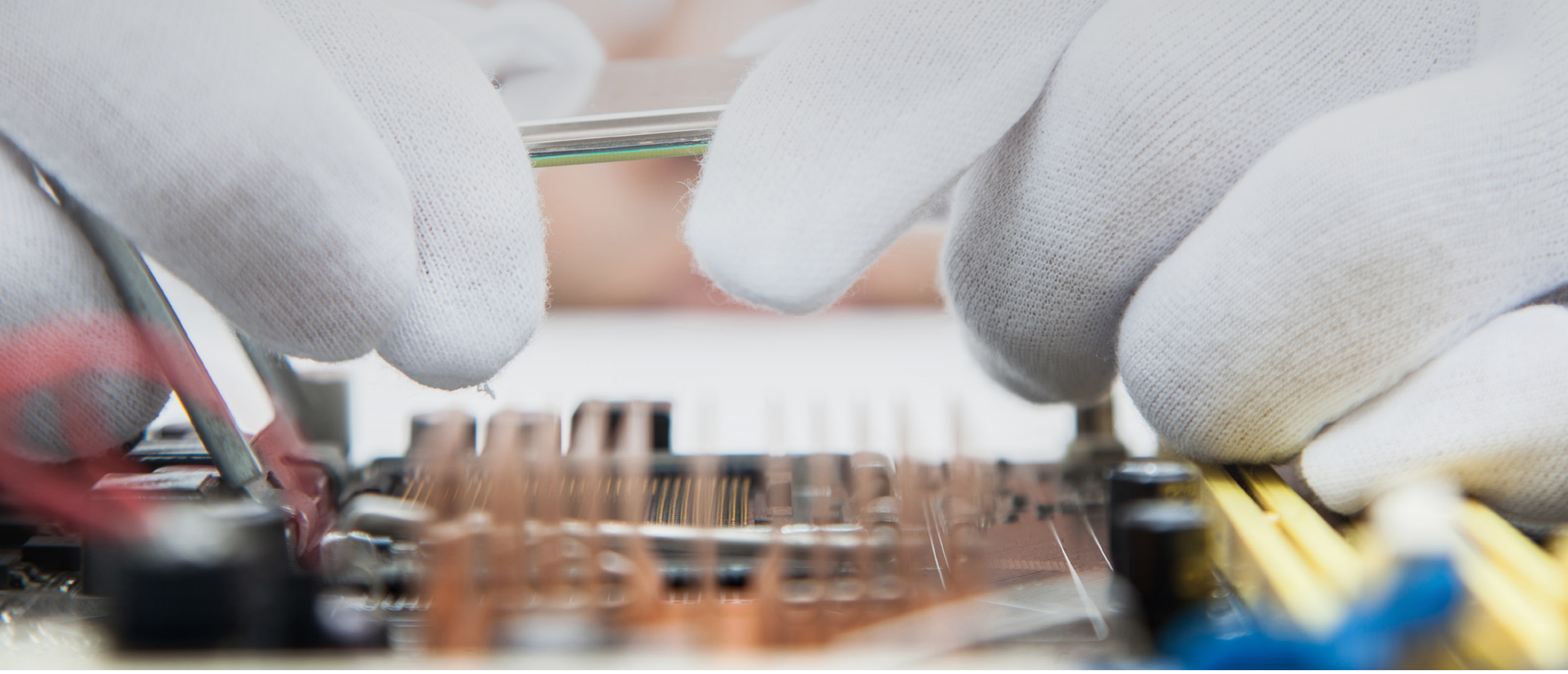
STRESS ENGINEERING SERVICES INC.

Polymers | Elastomers | Composites

Analytical Lab Services

- Dynamic Mechanical Analysis (DMA)
- Differential Scanning Calorimetry (DSC)
- Fourier Transform Infrared Spectroscopy (FTIR)
- Thermomechanical Analysis (TMA)
- Thermogravimetric Analysis (TGA)

SES provides physical, chemical, mechanical and thermal analysis of a broad range of materials. From the non-metallic world of polymers, elastomers, and polymer based composites to liquids and lubricants, and also traditional metallic materials, SES has the experience to identify and develop the test method required, conduct the testing, and interpret the results. Contact us today with your analytical services needs.



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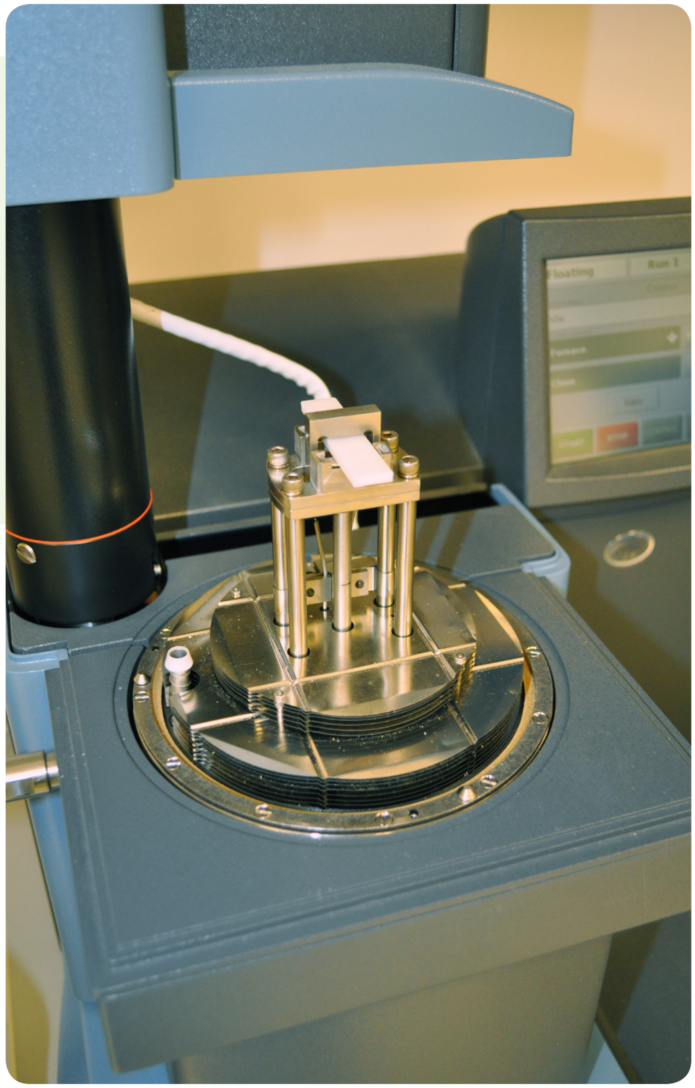
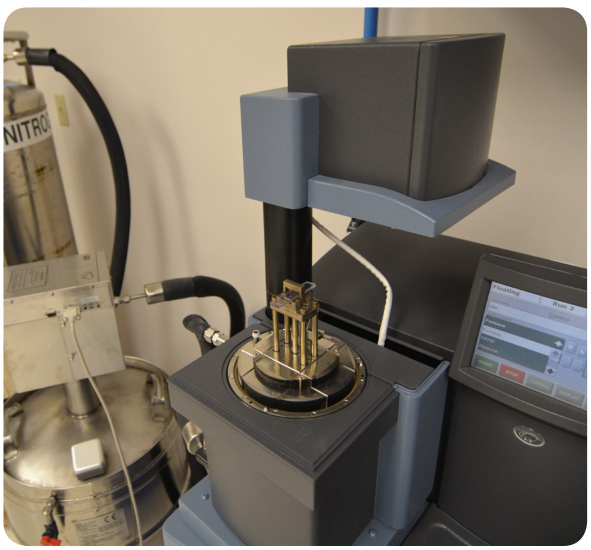
DYNAMIC MECHANICAL ANALYSIS (DMA)

SES provides **Dynamic Mechanical Analysis** (DMA) of polymers, elastomers, composites and ceramics. The DMA allows for the modeling of master material curves, stress relaxation behavior, glass transition temperature, as well as other high end material based experiments.



Common DMA fixtures used for testing by SES include:

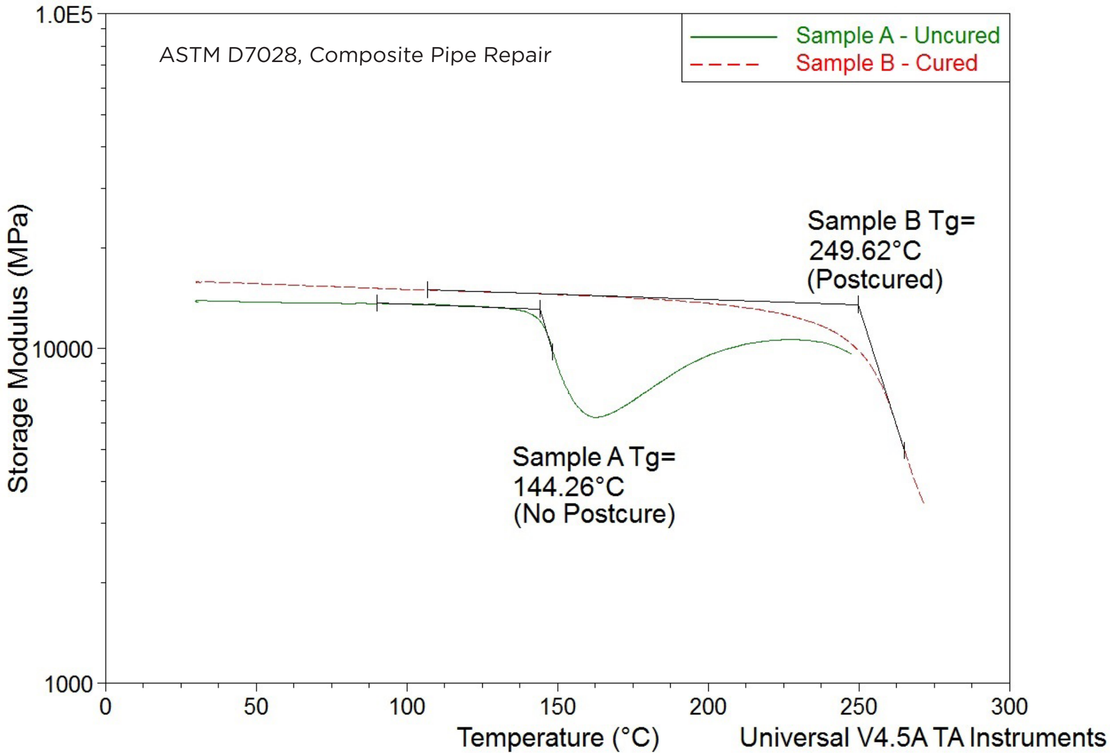
- Dual Cantilever
- Compression ASTM D7028
- Three-Point Bending
- Thin Film (Tension)



INSTRUMENT CAPABILITIES

TEMPERATURE RANGE	-150°C to 600°C
MAXIMUM FORCE	18 N
MINIMUM FORCE	0.0001 N
FORCE RESOLUTION	0.00001 N
STRAIN RESOLUTION	1 NANOMETER
FREQUENCY RANGE	0.01 to 200HZ
HEATING RATE	0.1°C to 20°C PER MINUTE
COOLING RATE	0.1°C to 10°C PER MINUTE

Sample A shows a decline in storage modulus followed by an increase; this indicates a sample that is not fully cured. After post curing (Sample B), the sample shows a higher Tg and is fully cured.



The DMA can also be used to determine stress/strain behavior of ultra-thin films that would be difficult to characterize on conventional test equipment. The material properties can then be used to simulate non-linear structural behavior of products, devices, and equipment.

Sample geometry requirements are variable and depend on the technique and fixture used during testing. SES conducts analysis using both standardized and customized methodology. A list containing common test methods is shown below. SES has developed several custom methods for analyzing material characteristics.

STANDARD TESTS

ASTM D7028, E1640	GLASS TRANSITION TEMPERATURE (Tg)
ASTM D4065, D5279	STANDARD DMA
ASTM D4473	CURE BEHAVIOR OF THERMOSETS

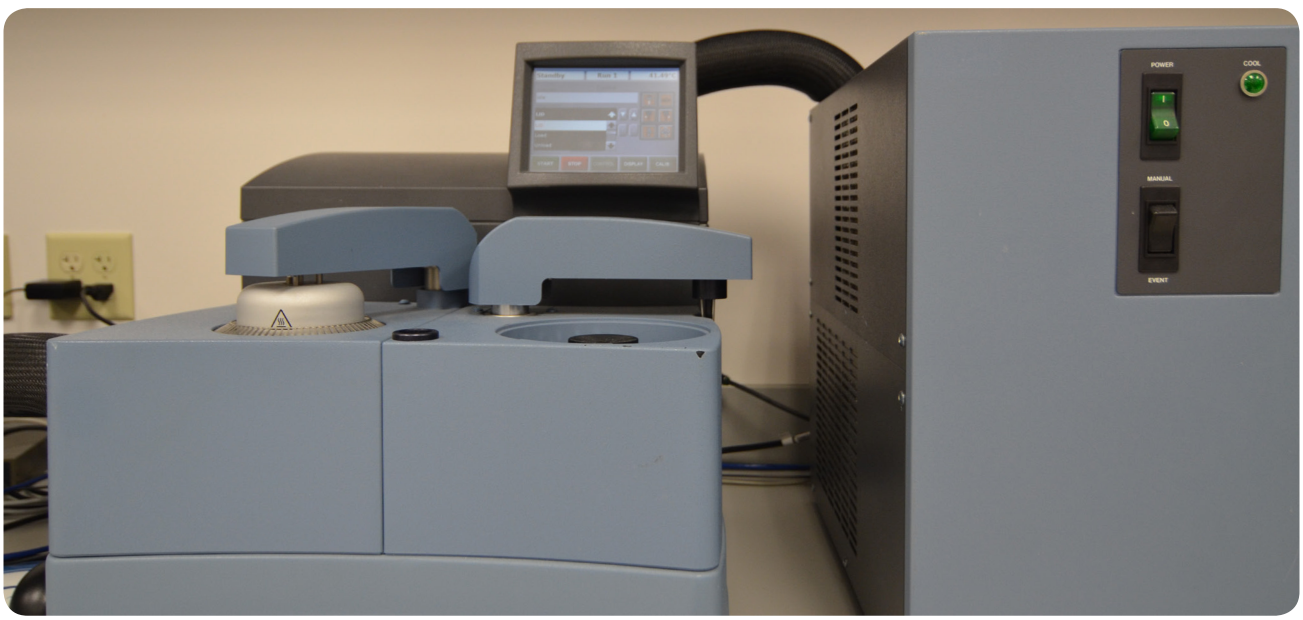
PRICING

1 Sample (Temp > 23°C)	**Email polymers@stress.com**
1 Sample (Temp < 23°C)	**Email polymers@stress.com**

DIFFERENTIAL SCANNING CALORIMETRY (DSC)

SES provides **Differential Scanning Calorimetry** (DSC) for thermal analysis of polymers, elastomers, polymer based composites and liquids to support a variety of industrial market sectors and functions.

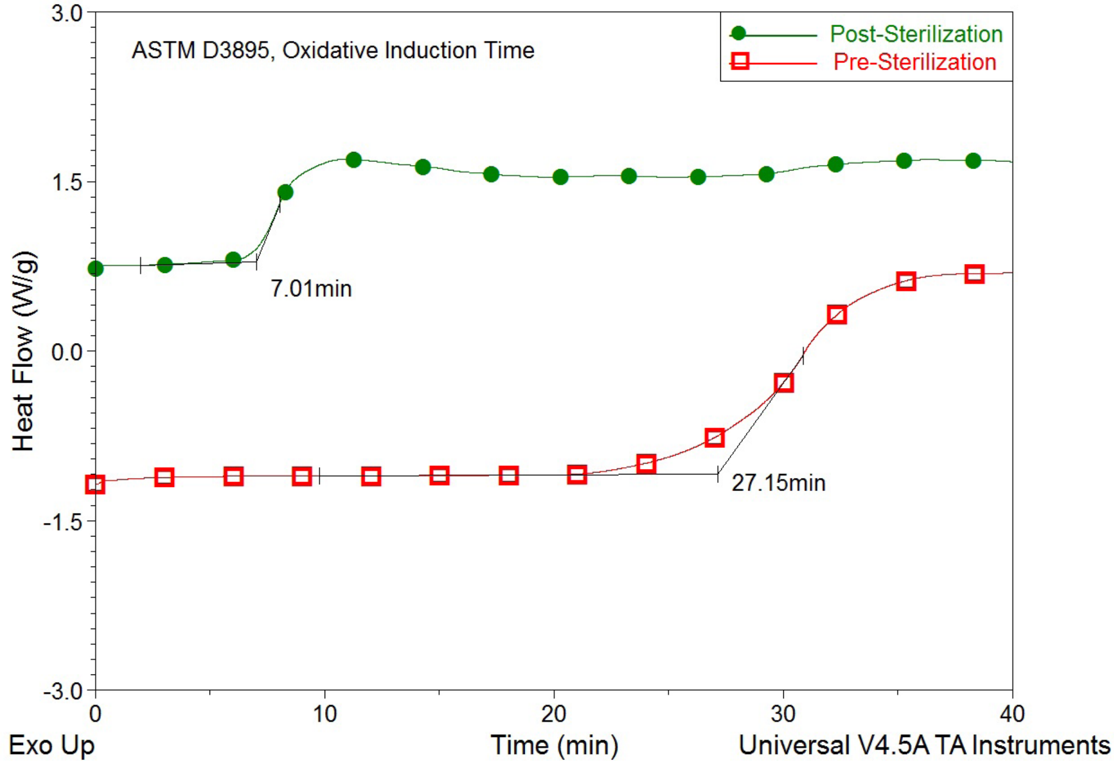
DSC can be used to determine the effect of thermal aging, chemical aging and medical sterilization. It is also a valuable compositional analysis tool, making it useful for reverse engineering. Material samples can be as small as 0.5 mg. SES conducts analysis using both standardized and customized methodology. A list containing common test methods is provided on the following page.



INSTRUMENT CAPABILITIES

TEMPERATURE RANGE	-180°C to 725°C
TEMPERATURE ACCURACY	± 0.1°C
TEMPERATURE PRECISION	± 0.05°C
CALORIMETRIC PRECISION	± 0.1%
CALORIMETRIC REPRODUCIBILITY	± 0.1%
HEATING RATE	0.1°C to 200°C PER MINUTE
COOLING RATE	0.1°C to 50°C PER MINUTE
PURGE GAS AVAILABILITY	NITROGEN, OXYGEN, AIR, ARGON, HELIUM

This plot is of a polyethylene sample extracted from a medical component before and after sterilization. The oxidative induction time (OIT) measures the amount of stabilizer in the resin. When the heat flow increases from the baseline, this indicates the stabilizer has been depleted. In this example, while reduced during gamma sterilization, the stabilizer is still present post-sterilization. The shift distinctly shows the reduction in stability caused by the depletion of stabilizer.



STANDARD TESTS

ASTM D7426, E1356	GLASS TRANSITION (Tg) VIA DSC
ASTM D3895, E1858	OXIDATIVE INDUCTION TIME VIA DSC
ASTM D3418	TRANSITION TEMPERATURES OF POLYMERS
ASTM E2070	KINETIC PARAMETERS VIA ISOTHERMAL DSC
ASTM E928	DETERMINATION OF PURITY VIA DSC
ASTM E1269	DETERMINATION OF SPECIFIC HEAT CAPACITY
ASTM E793	ENTHALPIES OF FUSION/CRYSTALLIZATION
ISO 11357/22768	MELTING AND CRYSTALLIZATION/Tg ANALYSIS
ASTM D1519	RUBBER CHEMICAL MELTING RANGE

PRICING

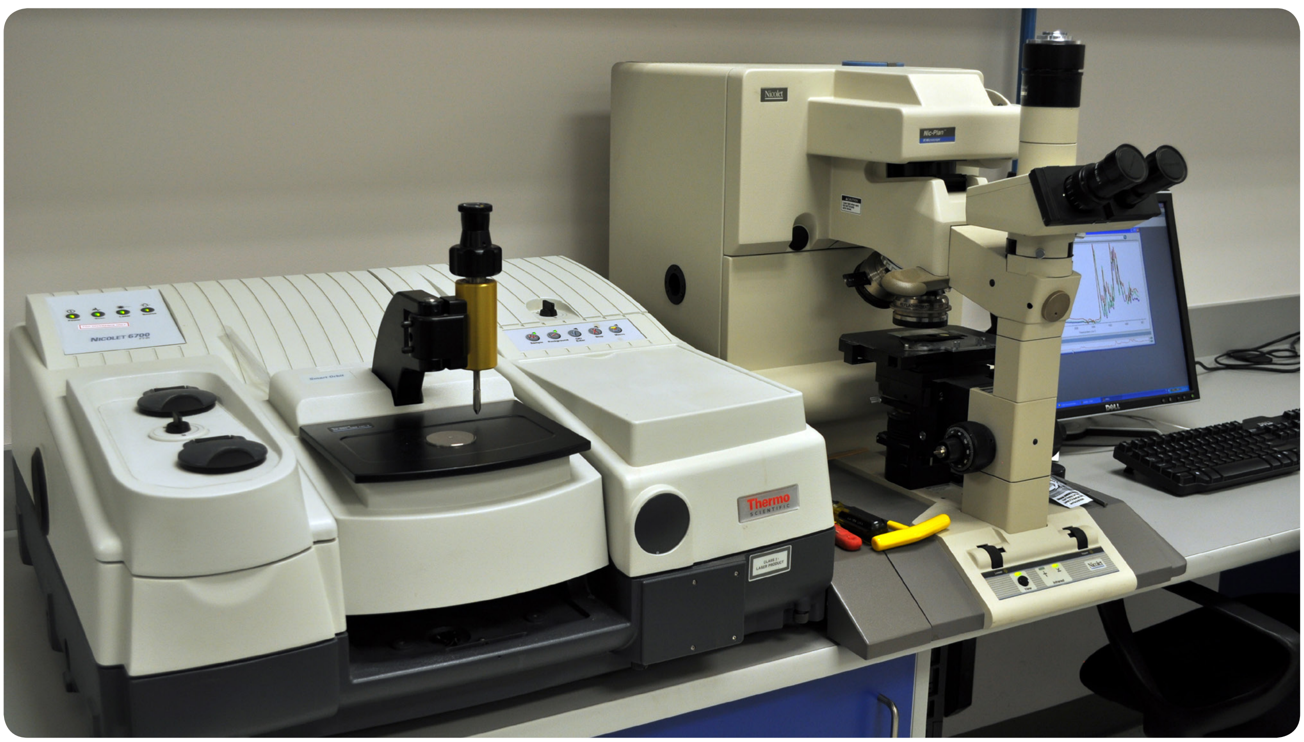
1 Sample	**Email polymers@stress.com**
2-4 Samples	**Email polymers@stress.com**
5+ Samples	**Email polymers@stress.com**

FOURIER TRANSFORM INFRARED SPECTROSCOPY (FTIR)

SES uses **Fourier Transform Infrared Spectroscopy** (FTIR) to identify organic compounds, polymeric materials and additives. FTIR testing is a common technique used to identify unknown polymers and organic compounds.

FTIR is a classic reverse engineering technique that can be used to determine a polymer class (thermosetting vs. thermoplastic) and family (i.e. Nylon, Polyethylene, Polypropylene). By focusing on subtleties in the spectra produced for polymers, further identification and delineation is possible (i.e. Homopolymer Polypropylene can be differentiated from Copolymer Polypropylene).

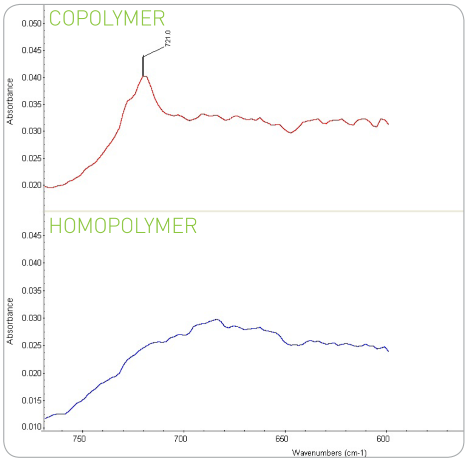
FTIR is generally a surface technique (i.e. infrared penetration of 2-5 µm). However, it is capable of determining whether a material has been contaminated and in some cases, degraded. The fingerprint for each material is unique and distinct. In certain cases, FTIR must be coupled with other techniques (such as Differential Scanning Calorimetry, Raman Spectroscopy, or SEM).

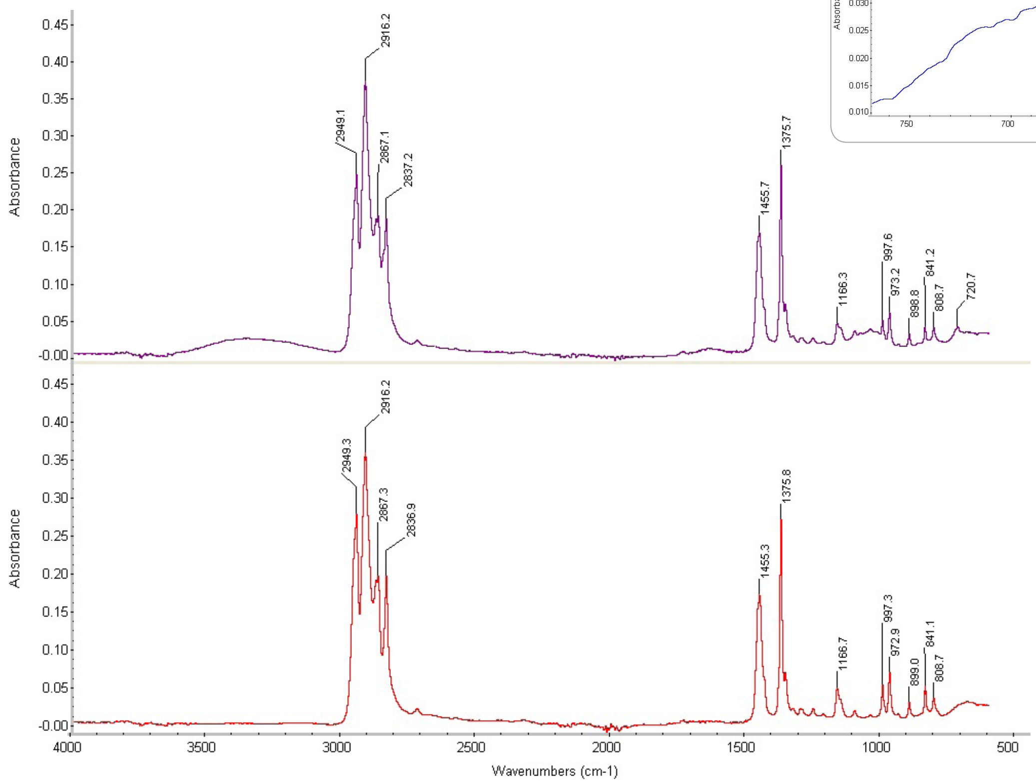


INSTRUMENT CAPABILITIES

MICRO-FTIR	AVAILABLE
DIAMOND PLATE	AVAILABLE
GERMANIUM PLATE	AVAILABLE
LIQUID SAMPLES	YES
SOLID SAMPLES	YES
LIBRARY SPECTRA	>13,000

The following samples are both Polypropylene. Homopolymer and copolymer polypropylene have significant performance differences. In the case in which a product is performing below expectations, it is possible to determine if the appropriate resin was used. The crystalline peak at 720 cm^{-1} is associated with ethylene and indicates the material is copolymer polypropylene. The lack of a distinct peak at 720 cm^{-1} indicates homopolymer polypropylene.





SES conducts analysis using both standardized and customized methodology. A list containing common test methods is shown below. Employing a database with 1000s of library spectra, SES is capable of identifying most unknown materials.

STANDARD TESTS

ASTM E168	QUANTITATIVE FTIR ANALYSIS
ASTM E1252	QUALITATIVE FTIR ANALYSIS

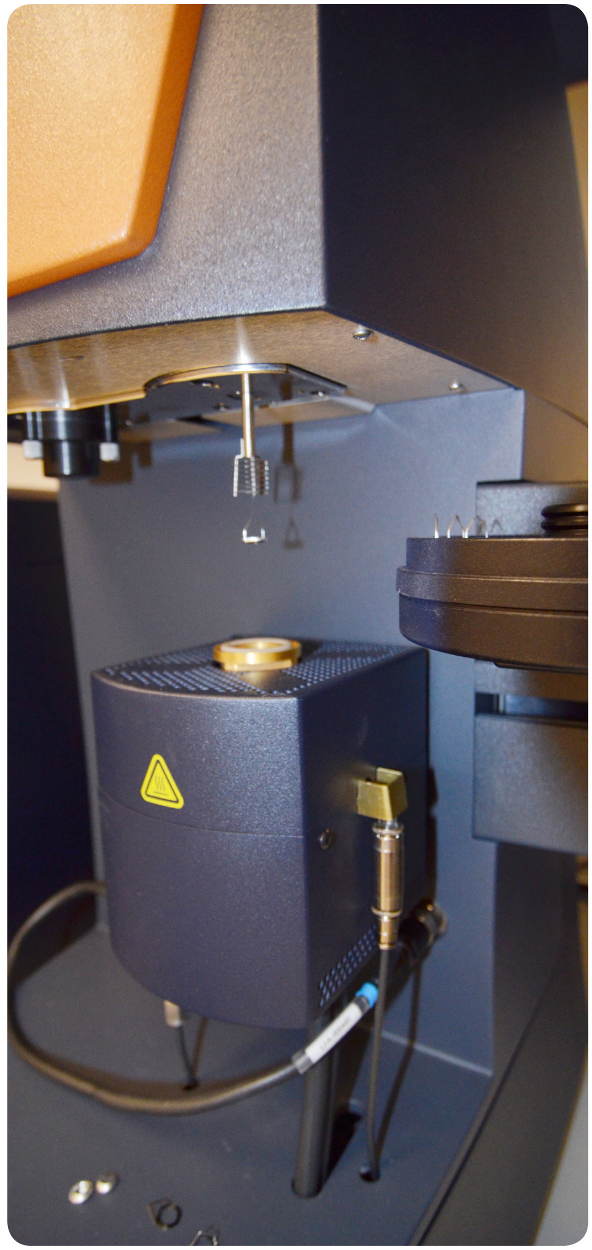
PRICING

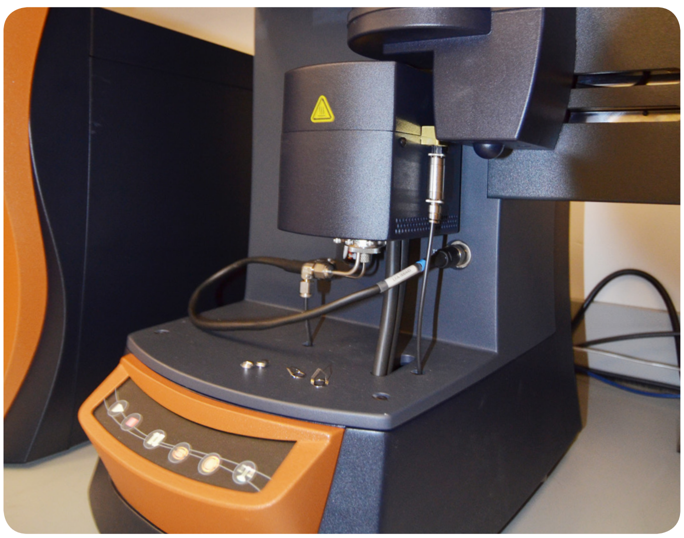
1 Sample	**Email polymers@stress.com**
2-4 Samples	**Email polymers@stress.com**
5+ Samples	**Email polymers@stress.com**

THERMOGRAVIMETRIC ANALYSIS (TGA)

SES provides **Thermogravimetric Analysis** (TGA) for thermal analysis of polymers, polymer based composites and elastomers. TGA can be used to determine the kinetics of decomposition of a material, the distillation temperature of a liquid, the effect of aging and medical sterilization, and the effect of prolonged exposure at static temperatures.

It is a valuable technique when used to analyze the organic/inorganic composition of a material. Samples can be as little as 1 mg. TGA testing can occur in various gaseous environments (Nitrogen, Oxygen, Air, etc.). SES conducts analysis using both standardized and customized methodology. A list containing common test methods is provided on the following page.

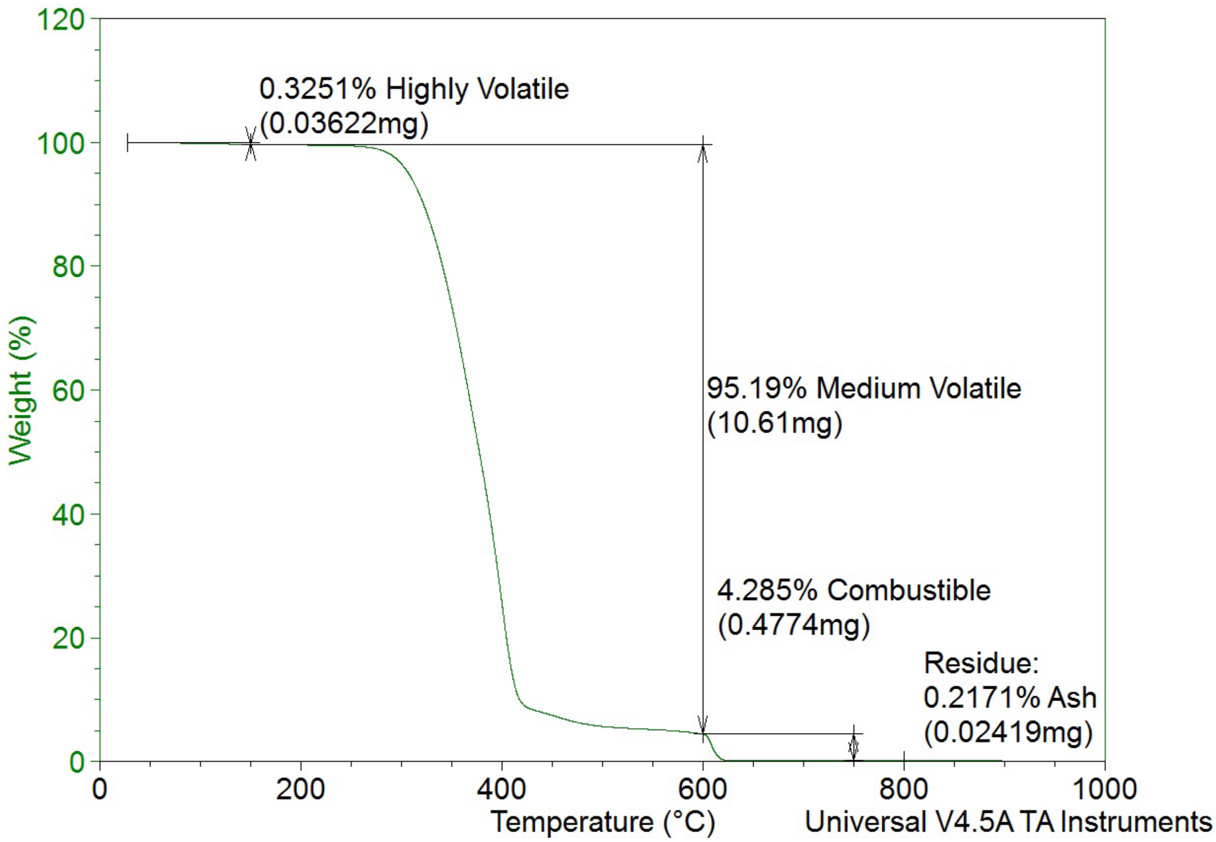




INSTRUMENT CAPABILITIES

TEMPERATURE RANGE	23°C to 1000°C
ISOTHERMAL TEMPERATURE ACCURACY	± 1.0°C
ISOTHERMAL TEMPERATURE PRECISION	± 0.1°C
BALANCE CAPACITY	1.0 G
WEIGHING PRECISION	± 0.01%
BALANCE SENSITIVITY	0.1 µG
HEATING RATE	0.1°C to 100°C PER MINUTE
PURGE GAS AVAILABILITY	NITROGEN, OXYGEN, AIR, ARGON, HELIUM

ASTM E1131 provides compositional information about a sample.The weight loss regimes correspond to plasticizers, additives, and fillers. Comparative analysis of materials pre- and post- application exposure can assist with determining failure mechanisms.



STANDARD TESTS

ASTM E1131	COMPOSITIONAL ANALYSIS VIA TGA
ASTM D6370	ELASTOMER COMPOSITION ANALYSIS VIA TGA
ASTM D2584	IGNITION LOSS OF CURED REINFORCED RESINS
ASTM D6558	CO2 REACTIVITY OF ANODE/CATHODE BLOCKS
ASTM D3850	RAPID DEGRADATION OF ELECTRICAL COMPOSITION
ASTM D6375	EVAPORATION LOSS OF LUBRICATING OILS

PRICING

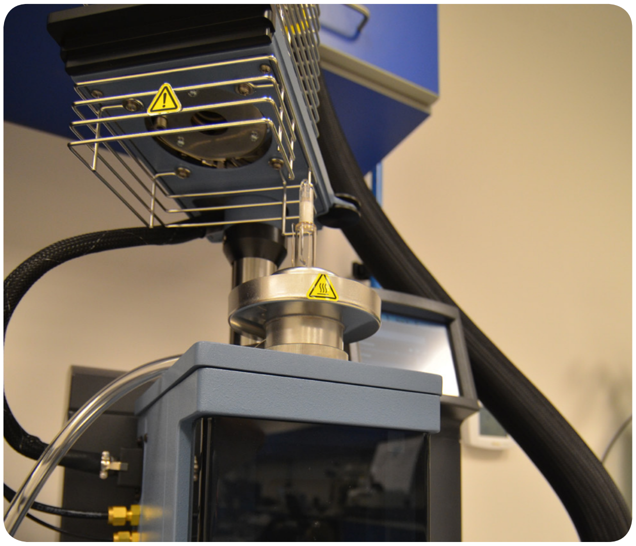
1 Sample	**Email polymers@stress.com**
2-4 Samples	**Email polymers@stress.com**
5+ Samples	**Email polymers@stress.com**

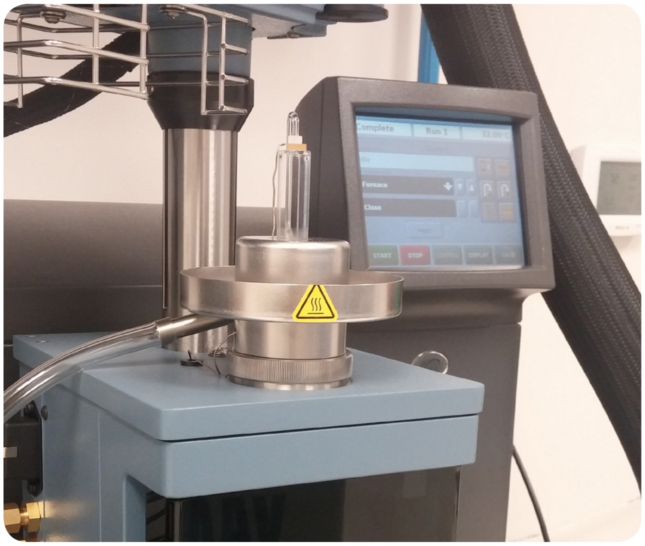
THERMOMECHANICAL ANALYSIS (TMA)

SES provides **Thermomechanical Analysis** (TMA) of metallic and non-metallic coupons to acquire properties related to the coefficient of thermal expansion. Characterization of polymers, elastomers, adhesives, composites, ceramics, glasses and metallic substrates is possible with this analytical characterization instrument.

Typical Applications for the TMA include:

- Measurement of Dimensional Change Coefficient of Linear Thermal Expansion
- Multi-layer film analysis
- Determination of Material Anisotropy
- Determination of Softening Temperatures
- Determination of Glass Transition Temperature
- Difficult to measure Glass Transition Temperatures



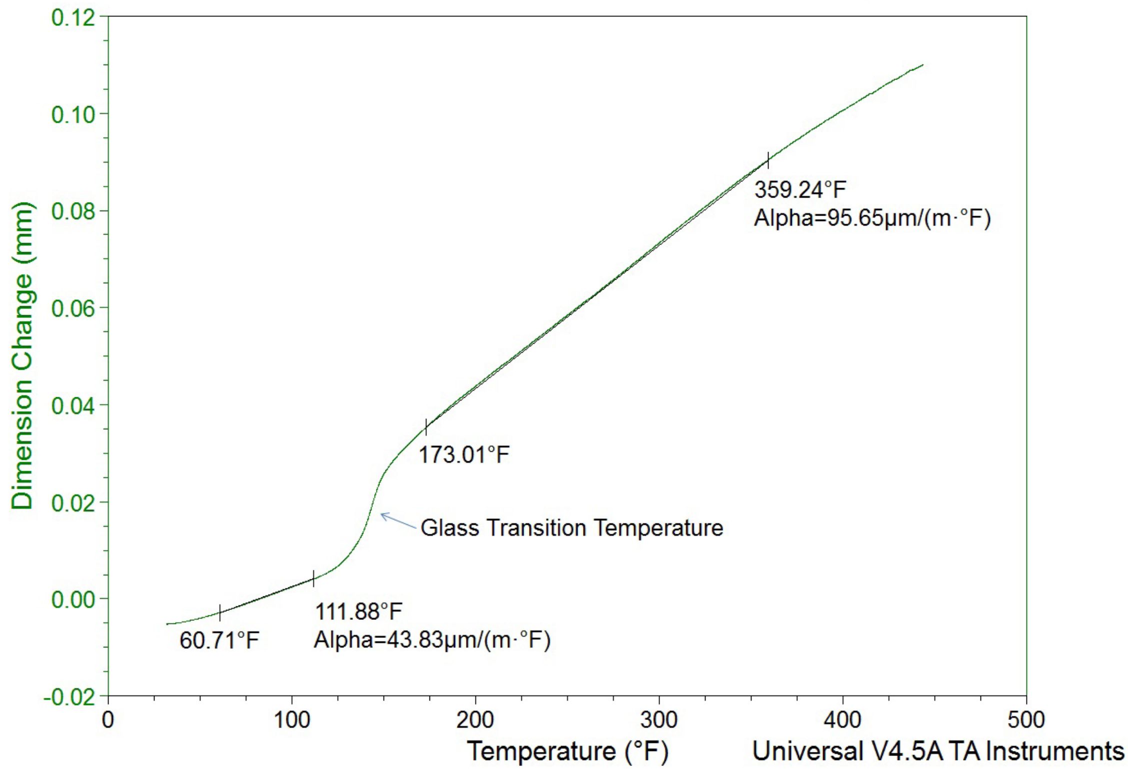


INSTRUMENT CAPABILITIES

TEMPERATURE RANGE	-150°C TO 1000°C
SENSITIVITY	15 NANOMETERS
FORCE RANGE	0.001 N TO 2.0 N
FORCE RESOLUTION	0.001 N
MEASUREMENT PRECISION	± 0.1%
TEMPERATURE PRECISION	± 1°C
TYPICAL HEATING RATE	0.1°C TO 5°C PER MINUTE
PURGE GAS AVAILABILITY	NITROGEN, OXYGEN, AIR

TMA

Polymers, composites, and elastomers have temperature dependent thermal expansion properties. This example of an epoxy resin shows that there are two distinct regions of thermal expansion. When below the glass transition temperature, the linear coefficient of thermal expansion is less than half the value of that when above the glass transition temperature. In electronic component applications, selecting the appropriate materials and understanding the thermal operating map can reduce strain on components from thermal expansion.



TMA is a valuable test method for failure analysis, application development, material development, computational analysis, material characterization and competitive analysis.

STANDARD TESTS

ASTM E831	LINEAR THERMAL EXPANSION OF SOLID MATERIALS
ASTM D3386	LINEAR EXPANSION OF INSULATING MATERIALS
ASTM D696	LINEAR EXPANSION OF PLASTICS
ISO 11359	TMA OF THERMOPLASTICS AND THERMOSETS
DIN 51 005	THERMOMECHANICAL ANALYSIS

PRICING

1 Sample	**Email polymers@stress.com**
2-4 Samples	**Email polymers@stress.com**
5+ Samples	**Email polymers@stress.com**

Call SES Today at 513-336-6701

CONTACT INFORMATION

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