

# Specifications

## Standard Reference Instrument Series 6005

### Polymerization Stress Tensometer

**Description:** The Polymerization Stress Tensometer (PST) is a cantilever-beam based measurement instrument that combines beam deflection mechanics with capacitive sensor technology to measure real-time polymerization shrinkage stress (PS) during the photocuring process for composite resins.

A LabVIEW-based graphical user interface (GUI) developed at NIST is provided with the PST to enable the user to specify the curing mode and irradiation parameters using a light-emitting diode (LED) and light intensity control system. The PST and GUI software are delivered ready for the integration of thermocouple and near-infrared spectrometer; thus, PST/GUI simultaneously provides real-time kinetics data with accuracy and sensitivity on polymerization shrinkage stress, degree of cure, and reaction exotherm. The PST and PST/GUI are interchangeable in this specification.

Design, assembly and technical measurements leading to the production of this SRI were performed by the NIST Biosystems and Biomaterials Division in Gaithersburg, Maryland. Support aspects involved in the issuance of this SRI were coordinated through the NIST Office of Reference Materials.

**Specifications:** NIST provides the PST as Standard Reference Instrument (SRI) with performance that is equivalent to that of NIST systems in terms of mechanical accuracy, provided that operators follow recommended best practices and perform intercomparisons with comparable stress measurement sources. The NIST PST SRI is offered in two standard configurations. The PST cantilever beam with holder and base stand are fabricated and packaged by NIST in accordance with existing and established fabrication protocols. The PST SRI is constructed using commercially available components and includes software that optimizes operator control and produces real-time measurement results.

NIST researchers continue to develop and improve the PST system and measurement techniques. The PST components/systems and associated measurement capabilities are identical to those of NIST systems at the time of acquisition. Prices do not include support, training, and on-site demonstration.

Anne L. Plant, Chief  
Biosystems and Biomaterials Division

Steven J. Choquette, Director  
Office of Reference Materials  
Material Measurement Laboratory

Gaithersburg, MD 20899  
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## Standard Configurations:

- 6005a** The base PST components and systems have the following specifications and features.<sup>1</sup>
- A capacitive probe tested and demonstrated to produce stable, measurable voltages over the range from -10 volts to +10 volts over a 2,000  $\mu\text{m}$  measurement distance.
  - Several system components that are commercially available.
  - Operating input current for light intensity control up to a recommended 1000 mA.
  - A NIST-designed custom base stand, stainless steel cantilever beam, electronic and hardware integration components, cables, 2.5mm and 6mm-diameter collets, and X-Y stage controls.
  - Custom LabVIEW software that provides user input control, data acquisition displays, and file saving options.
  - The capability to change the curing light system (LED) installed in the PST.
- 6005b** Includes the PST base model plus a power activator kit to initiate the polymerization process. The power activator kit includes a LED light irradiator for a targeted wavelength and a light intensity controller system.

**Delivery and Shipping:** Unless otherwise agreed by the parties, shipping terms shall be [EXW \(Incoterms 2010\)](#). NIST will prepare packaging for shipment of the PST SRI. Shipping crate dimensions and weight will be included in each quote. Customers are responsible for arrangement of shipping pickup at NIST as well as all customs duties and import fees (HTC 9024.80.0000).

**Installation:** Installation is not included in the price of the product and the customer should contact the technical division for information regarding the initial setup, training and support of this SRI.

**Technical requirements at installation site:** Customers must provide the following:

- A) A Windows-based computer with universal serial bus (USB) ports, sufficient memory for PST software (minimum 1GB RAM, 5.5GB disk space) and a CD-ROM drive for software installation.
- B) Software and licenses for National Instruments LabVIEW Full Development and MathScript RT Module (32-bit version, 2013 or later). Note: MathScript RT Module currently does not support 64-bit LabVIEW software installations.
- C) Customs related clearances, documents, payments, and fees.
- D) Appropriate power and utilities for the PST components, including earth-grounded power outlets and connectors.
- E) Any replacement commercial instruments and components that are integrated into the PST system other than what is installed by NIST.
- F) Any sample materials, cables, rods, sleeves, LEDs, etc. other than those supplied by NIST at installation.

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<sup>1</sup> Certain commercial equipment, instruments or materials are identified in this certificate to adequately specify the experimental procedure. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

- G) Spacers for setting the sample height in the PST.
- H) Shielding of the PST from interfering external light sources such as outdoor light, fluorescent light, other instruments, etc.
- I) A level, non-slip, non-conducting surface with sufficient space for installing the PST.
- J) A location for the PST that is not exposed to excessive heat, moisture or vibration.

**Polymerization Stress Tensometer (PST) Configurations -6005 Cantilever beam-based PST**

- a. Custom NIST-developed LabVIEW graphical user interface software for PST control
- b. Custom NIST-developed cantilever beam holder, steel beam and 4-legged base stand with collets, collet closers, hex screws and X-Y stage adjustment knobs
- c. Lion Precision CPL190 linear driver with  $\pm 10V$  sensitivity range and capacitive probe with shielded cable, power supply, BNC to alligator clip, and banana plug to alligator clip
- d. Custom NIST-developed metal target with locking nut for voltage measurements
- e. Analog to Digital Converter - Measurement Computing USB 2404-10 24-bit DAQ with  $\pm 10V$  range, USB cable and device driver software on compact disk
- f. Arroyo Instruments 6340 ComboSource laser diode and temperature controller with device driver software on compact disk
- g. Arroyo Instruments 226 TEC LED LaserMount
- h. Omega Super MCJ thermocouple-to-analog converter with male SMP plug
- i. Physitemp IT-23 Type-T 0.003" twisted pair thermocouple implantable probe
- j. LED Engin LZ1-10DB00 blue dental high power light-emitting diode

*Users of this SRI should ensure that the Specifications Certificate in their possession is current. This can be accomplished by contacting the Office of Reference Materials: telephone (301) 975-2200; fax (301) 948-3730; e-mail [srminfo@nist.gov](mailto:srminfo@nist.gov); or via the Internet at <http://www.nist.gov/sri>.*