

Specifications for a Fourier Transform Spectrometer System

1 Introduction

The Naval Research Laboratory requires a high resolution Fourier transform spectrometer system that is capable of making transmission and reflection measurements on samples at cryogenic temperatures. The instrument will be used for optical materials research as well as the development and testing of submillimeter, infrared, visible, and ultraviolet components and systems.

2 Scope

The contractor shall deliver, install, and test a complete Fourier transform spectrometer system at NRL, including all sources, beamsplitters, filters, and detectors required to cover the spectral range specified below. The system shall include an optical cryostat that can be mounted in the sample chamber of the spectrometer. A PC data system must be included, with software installed, to permit data collection and automated control of the spectrometer and cryostat. Any additional equipment, such as pumping stations and cryogen transfer tubes, necessary for operation of the instrument and its accessories must also be included.

3 Technical Requirements

The contractor shall provide a Fourier transform spectrometer system that meets or exceeds the following specifications.

3.1 Spectral range

5 cm^{-1} to 50,000 cm^{-1}

3.2 Spectral resolution

0.1 cm^{-1}

3.3 Wavenumber accuracy

0.01 cm^{-1}

3.4 Stability

Deviation within 8 hours: < 2 % at 10,000 cm^{-1}

3.5 Mirror scan speed

Variable: at least 0.1 cm/sec to 10 cm/sec.

Rapid scan: up to 80 spectra/second.

The mirror mechanism must be usable for step scan as well as rapid scan measurements.

3.6 Vacuum chamber

- 3.6.1 The optical bench must be enclosed in a modular vacuum chamber, must reach a pressure of 5 mbar or less, and must permit the sample chamber to be vented without disturbing the vacuum in the rest of the spectrometer.
- 3.6.2 It must be possible to switch between at least three detectors and two sources without venting the vacuum system.
- 3.6.3 The vacuum box must have at least two exit ports with windows, so that the optical beam can be directed by computer control into external detectors or cryostats.
- 3.6.4 The selection of sources, detectors, filters, and samples must be computer controlled to permit automated operation and changes of spectral range without venting any part of the vacuum system.

3.7 Detectors, Sources, Beamsplitters

- 3.7.1 Detectors, filters, beamsplitters, and light sources must be supplied which cover the entire spectral range of the instrument.
- 3.7.2 Two bolometer detectors must be supplied with operating temperatures of 4.2 K and 1.6 K. They must be mounted in a single LHe dewar which mounts onto the spectrometer vacuum box.
NEP (4.2 K): = $2 \times 10^{-13} \text{ W Hz}^{-1/2}$
NEP (1.6 K): = $5 \times 10^{-14} \text{ W Hz}^{-1/2}$

3.8 Sample holders

Computer controlled sample holder mechanisms must fit into the sample chamber of the spectrometer and must be usable for room temperature transmittance and reflectance measurements. They must allow samples to be moved into and out of the optical beam while the sample chamber is under vacuum. Two sample holders are required.

- 3.8.1 #1 must hold up to eight 26 mm (1 inch) diameter samples.
- 3.8.2 #2 must hold two larger samples up to 10 cm square.

3.9 Reflectance accessory

This must be suitable for use with the optical cryostat, and must permit near normal incidence reflectance measurements (angle of incidence < 15 degrees).

3.10 Data system

A PC data system with Linux or Microsoft Windows operating system must be included for interferometer control, data collection, and data reduction.

Minimum configuration:

- 1 GHz Pentium III
- 40 GB hard disk
- 256 MB RAM
- 15 inch color monitor
- CD-RW drive
- 10 – 100 Mb/sec Ethernet card

3.11 Software

All software necessary for control of the interferometer and its accessories, and for acquisition, reduction, display, and plotting of experimental data must be included.

3.12 Optical cryostat

The spectrometer system must include an optical cryostat for transmittance and reflectance measurements on samples at cryogenic temperatures, which meets or exceeds the following specifications.

- 3.12.1 Sample chamber diameter: 1.5 inch
- 3.12.2 The sample must be cooled by continuously flowing He vapor.
- 3.12.3 Temperature range: maximum 300 K, minimum < 2.0 K.
- 3.12.4 Temperature stability: It must be possible to hold the sample chamber temperature constant to within 0.2 K, anywhere between 4.2 K and 300 K, for a period of no less than four hours.
- 3.12.5 Windows must be supplied which permit operation of the cryostat throughout the spectral range of the spectrometer. The windows must be easily demountable. It must be possible to mount four different window sets simultaneously. A window set consists of one warm and one cold window. Each window set must transmit > 70% in its usable spectral range.
- 3.12.6 A sample holder with the following specifications must be included:

- 3.12.6.1 The sample holder must permit two 1 inch diameter samples to be positioned, one at a time, in the optical beam in the cryostat sample chamber. It must be rigid to allow accurate reflectance measurements. It must be removable so that it can be replaced with other holders for different sized samples.
- 3.12.6.2 The sample holder must be rotatable about the vertical axis to enable optical alignment and variable angle measurements. The angle must not change between sample and reference positions.
- 3.12.6.3 A stepper motor must be installed on the sample positioner linear manipulator with a stepper motor controller and RS-232 interface to the PC.
- 3.12.7 Two temperature sensors must be installed in the cryostat: one on the sample holder, and one on the heat exchanger.
- 3.12.8 The following cryostat accessories must be included:
 - 3.12.8.1 A temperature controller that enables the sample temperature to be held constant by means of automated control of heater current and cryogen flow. It must permit remote control by the PC data system.
 - 3.12.8.2 Software and interconnect cables required for automated computer control of the temperature controller.
 - 3.12.8.3 A liquid helium transfer tube.
 - 3.12.8.4 All necessary hardware and vacuum seals to mount the cryostat in the sample chamber of the spectrometer for transmittance measurements.
 - 3.12.8.5 A high-vacuum pumping station for evacuating the cryostat vacuum jacket.

4 Installation and Integrating

The contractor is responsible for installing and integrating a fully functional system at NRL no later than 10 days after delivery of the system, 120 days, to the laboratory.

5 Test Data

The contractor, after installation, shall test all of the system's capabilities demonstrating the spectrometer's performance to comply with the specification. The test data must be delivered to NRL.

6 Technical Support

Telephone/fax technical support and troubleshooting assistance must be available from the contractor for the life of the instrument.

7 Training

The contractor shall provide training for the fourier transform spectrometer system. Training in the operation of the spectrometer and software for four NRL personnel at the vendor's site for a period of (3) three (8) eight-hour days. The operator manuals shall be used in the training session.

8 Warranty

The contractor must provide a standard commercial warranty for the fourier transform spectrometer system.