CRYOFREE

Application note

Applications of the Oxford Instruments' OptistatDry cryostat with the Vertex series of FTIR research systems

Introduction

Oxford Instruments and Bruker Corporation jointly announce the integration of Oxford Instruments' **Optistat**™Dry **Cryofree**® cryostat with Bruker's Vertex series of FTIR research spectrometers. This application note describes the capability of the **Optistat**Dry and Vertex combination, that can be applied to a wide range of spectroscopy experiments.

Figure 1. **Optistat**Dry mounted in a Bruker V70 FTIR spectrometer.

Background

Sometimes the availability and cost of liquid helium can be a factor in selecting a cryogenic system for low temperature investigations. To address these concerns, a closed-cycle cryogenic system is an excellent alternative. **Optistat**Dry uses a mechanical cooler. However, due to the design of the mechanical interface, interference due to vibration has been reduced to levels not detectable in the spectral regions of interest. The **Optistat**Dry has been coupled and fully integrated with Bruker's Vertex series of FTIR spectrometers. The cryostat can be utilised for characterising materials without the use of liquid helium. It is very easy to use, where samples can be changed without altering the alignment, the cool down time is approximately 160 minutes. The **Optistat**Dry has been adapted for use with the Vertex series of spectrometers, including the purged V70 and V80 (see Figure 1), as well as to the vacuum systems, V70v and V80v. The **Optistat**Dry is mounted directly to the V70 utilising Bruker's proprietary quicklock baseplate.

The **Optistat**Dry has been fully integrated such that the control of temperature and data collection is synchronised and easily performed via Bruker's OPUS software (Figure 2). Temperature ramps are easily setup such that data can be readily collected during increasing and decreasing temperature ramps. Since the acquired data has the associated temperature automatically stored, data analysis is greatly facilitated.

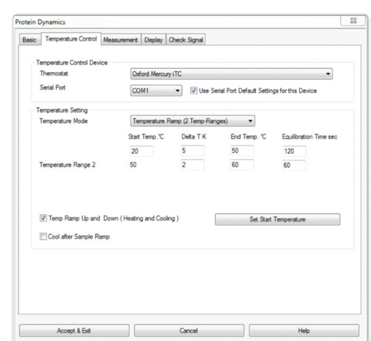

Figure 2. Screen capture of the temperature control user interface in Bruker's OPUS software (optional O/PRO package).

The Bruker VertexFM infrared spectrometer can cover the full spectral range, from 30 wavenumbers to 6,000 cm^{-1} in a single scan. While a bolometer is ideal for conducting measurements in the far infrared (FIR), due to it having much greater sensitivity than a DTGS detector, most samples can be analysed with a DTGS detector due to the high sensitivity of the Vertex FTIR spectrometers. This is particularly attractive in utilising the VertexFM configuration that has a DTGS detector with a diamond window to cover the NIR-FIR spectral range. The **Optistat**Dry can be configured with optical windows suitable for the spectral range of interest. The windows can be easily exchanged as the sample chamber is readily accessible.

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Application example – Boron in GaAs

There are a wide range of applications where the **Optistat**Dry and Vertex combination can be applied. These applications range from low temperature photoluminescence investigations to quantum dot research, to matrix isolation, and semiconductor materials characterisation. Figure 3 shows the single channel spectra of the background (top) and the 1.21 mm thick GaAs sample (bottom) collected with the **Optistat**Dry and Vertex 70 with the region of interest circled. The data was collected at 4 cm^{-1} with 3 mm polyethylene windows mounted on the **Optistat**Dry. The data collection time was five minutes. The Boron-10 isotope is easily observed and shifts significantly as a function of temperature as observed and shown in Figure 4. The excellent sensitivity of the system is demonstrated by the fact that high quality data was collected even though the polyethylene windows and GaAs sample are strongly absorbing in the region of interest.

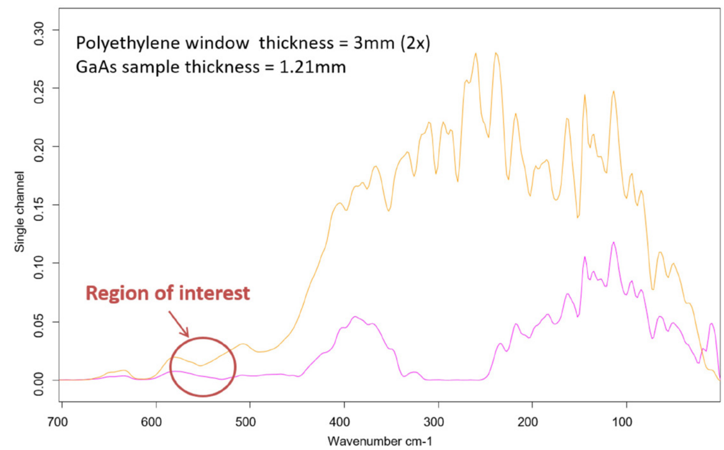

Figure 3. Single channel spectra of the **Optistat**Dry/Vertex70 system background (top) and the GaAs sample (bottom).

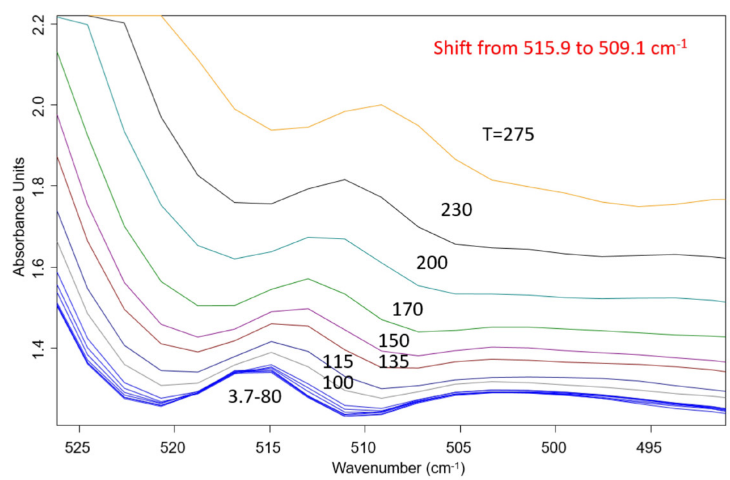

Figure 4. The absorbance spectra of the Boron-11 isotope in GaAs as a function of temperature.

Conclusion and outlook

Both the **Optistat**Dry and Vertex are systems that can grow as the research needs change. **Optistat**Dry is designed with a modular philosophy that allows the cryostat to evolve – start with a basic system and as experimental needs change, upgrade to additional functionality. For example, extra wiring, different sample holders, and windows can be added at a later date. The Vertex FTIR systems can also be readily upgraded to include other spectral ranges, step-scan (useful for photoluminescence work), IR microscopy, FT/Raman capability, and more.

Authors:
Tom Tague, Ph.D., Applications Manager, FTIR/Raman Products, Bruker Corporation, USA
Mark Jackson, Territory Sales Manager, Oxford Instruments NanoScience, USA

Contact us at:

Oxford Instruments NanoScience
nanoscience@oxinst.com
www.oxford-instruments.com/nanoscience