Application Note: 50718

Performance Characteristics of the Advanced ETC EverGlo IR Source

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Key Words

- High Intensity IR Source
- IR Source Lifetime
- Signal-to-noise Ratio
- Stability

Introduction

The infrared (IR) light source makes a significant contribution to the performance of an IR spectrometer. The signal-to-noise ratio of the instrument is directly related to the source energy, but several other instrument performance parameters also depend upon the design of the source, including:

- Spectral Range
- Stability
- Lifetime
- Serviceability

In this application note, the new, Thermo Scientific proprietary Electronically Temperature Controlled (ETC) EverGlo* IR source will be described.

ETC EverGlo IR Source

The Nicolet™ FT-IR series spectrometer includes the most advanced ETC IR source in the industry. The ETC EverGlo vastly improves the industry standards set by the EverGlo source from Thermo Scientific previously. In addition to its superior stability and energy output, ETC EverGlo is the only source available that is capable of operating in three distinct modes – Normal, Turbo, and Rest.

Stabilized Normal Mode

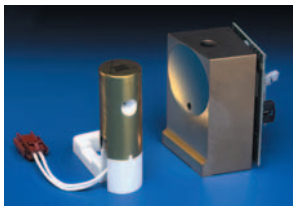

Figure 1: Source mirror

In the Normal operating mode, the source temperature is constantly monitored and controlled at 1140°C by the ETC EverGlo circuit mounted on the back of the source mirror, as shown in Figure 1. The radiation reaches the ETC EverGlo board through an orifice on the source mirror. This ensures extremely stable output from the source, and a more consistent performance over its lifetime.

Elevated Turbo Mode

For highly demanding, energy-limited FT-IR experiments (such as imaging, diffuse reflectance, and photoacoustic) that require an extra shot of energy, the Turbo mode enables the user to increase the temperature of the source to 1250°C. There is an increase in intensity of 25 – 45% from 2200 – 4000 cm^{-1}, as shown in Figure 2.

Users can set the source to Turbo mode through the experiment setup tool in OMNIC software, as shown in Figure 3.

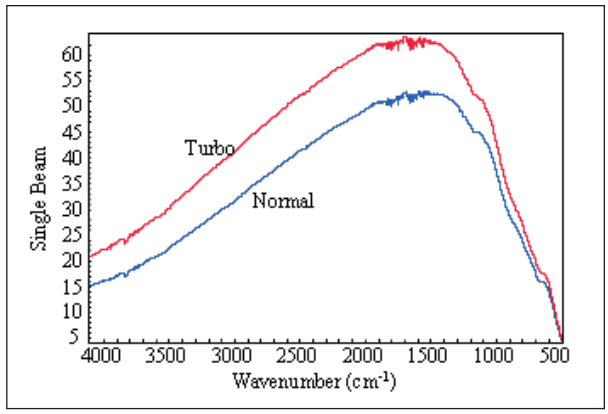

Figure 2: Single beam intensity comparison of Turbo and Normal operation modes

Parameter	Value
Sample compartment	Main
Detector	MCT/B
Beamsplitter	KBr
Source	IR Turbo
Accessory	None
Window	None
Recommended range	4000 ---- 400
Max range limit	4000
Min range limit	400
Gain:1	Autogain
Velocity	0.6329
Aperture	100
Sample shuttle	

Figure 3: Turbo mode set up with OMNIC software

Life-Prolonging Rest Mode

Allowing the source temperature to be lowered during periods of inactivity prolongs the life and improves the long term output of the source. The temperature of the source is dropped to 900°C if the spectrometer has been inactive for a period of time pre-specified by the user. The source returns to full power quickly, so spectra can be collected immediately when the user is ready again. For spectra that might require quantitative analysis, a wait period is recommended, although the time to return to normal operating temperatures is within seconds. Users can specify a time in the evening to set the source to Rest mode, and another time in the morning for the source to

**Patent pending*

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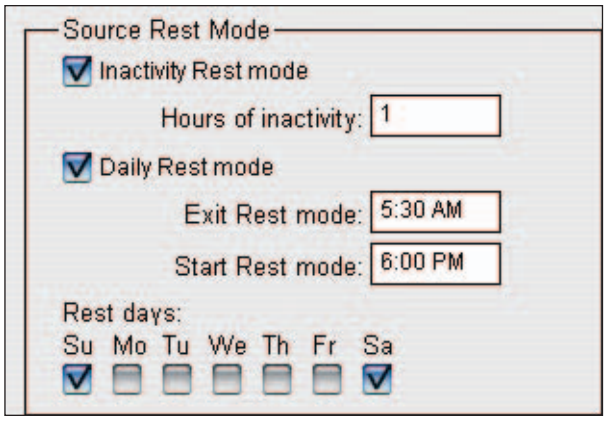

Figure 4: Intuitive interface allows users to set times of inactivity, prolonging the source's lifetime

power up, so that it is operating optimally by the time the user is ready to start collecting spectra. In addition, users have the option of selecting entire days (such as weekends) when the source can be in the rest mode for the entire 24-hour period. As shown in Figure 4, all of the available options in Rest mode are easily set by the user with OMNIC™ spectroscopy software.

Source Intensity

The source intensity must be sufficient to provide a high signal-to-noise level, but not so intense as to alter the sample or saturate the detector. Source outputs are often compared by evaluating the operating temperature of the source or by measuring the amount of power available in the sample compartment. However, since full analysis involves the energy that reaches the detector after making its way through the sample, comparing the single-beam energy of each source allows the user to make a better evaluation. The relative intensities of a water-cooled source, traditional air-cooled source and the ETC EverGlo (Normal mode) IR source are compared using their single-beam emission curves. Figure 5 shows the energy spectra for each plotted on an identical y-axis. For exact comparison, all sources were run on the same spectrometer, the only difference being the positioning of the source.

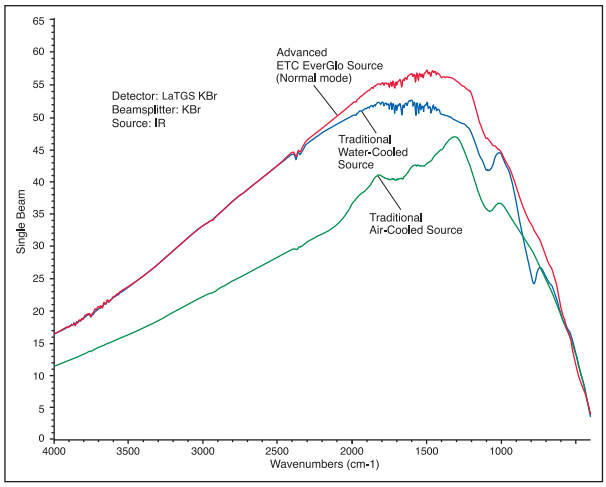

Figure 5: Relative intensities of water-cooled, air-cooled, and ETC EverGlo infrared sources

These data reveal that the advanced ETC EverGlo source, with its proprietary source element, optimized optical layout, and ultra-efficient, insulating material, provides as much energy as the traditional water-cooled source over the 4000 – 400 cm^{-1} spectral region and significantly more energy than the traditional air-cooled source in the mid-infrared region. The signal-to-noise ratio using the ETC EverGlo source on the Nicolet FT-IR series spectrometer is excellent. Figure 6 shows the result of a one-minute data collect in Normal mode with a baseline noise of less than 5.0 x 10^{-6} absorbance units (equivalent to 50,000:1 peak-to-peak).

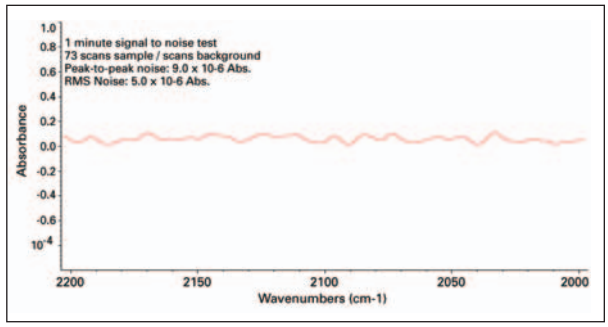

Figure 6: One-minute data collect results in normal mode

Stability

The stability of an infrared spectrometer, and thus the spectral reproducibility are highly dependent upon the stability of the IR source. The ETC EverGlo source is an efficient ceramic, refractory composite that rapidly rises to operating temperature and is also thermally insulated to maintain a constant operating temperature. A water-cooled source requires about 10 times as much input power to provide the equivalent amount of output energy of the ETC EverGlo source. Furthermore, the water-cooled source is subject to temperature fluctuations due to the incoming water supply. Traditional air-cooled sources are designed for low cost and are only minimally insulated or not insulated at all. For this reason, an excess input power causes a shortened lifetime.

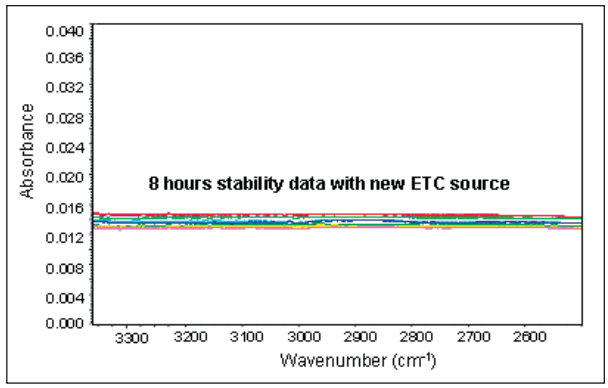

Figure 7: Stability data over 8 hours with a non-purged Nicolet 8700 spectrometer equipped with a room temperature DLaTGS detector

Figure 7 shows stability data of about ± 0.001 absorbance unit over eight hours data collection time between the region of 3200 cm^{-1} and 2600 cm^{-1}. A non-purged Nicolet 8700 FT-IR spectrometer, equipped with the ETC EverGlo IR source and a room temperature LaTGS detector were used in the data collection. It is expected that the stability data can be further improved with our TE-cooled LaTGS, or liquid nitrogen-cooled MCT detector.

Spectral Range

On research systems, the advanced ETC EverGlo IR source is also generally used to cover the 400 – 50 cm^{-1} far infrared region and the first portion of the near-infrared region from 7400 – 4000 cm^{-1}. Traditional air-cooled sources often perform very poorly in these extended spectral regions. An ideal source would provide sufficient energy for these ranges without compromise. This effectively demonstrates the spectral range of the ETC EverGlo IR source by collecting single-beam spectra for these spectral regions. Figures 8 and 9 show that by using the appropriate beamsplitter and IR detector in combination with the ETC EverGlo source, we can provide energy for the spectral region from 7400 – 50 cm^{-1}.

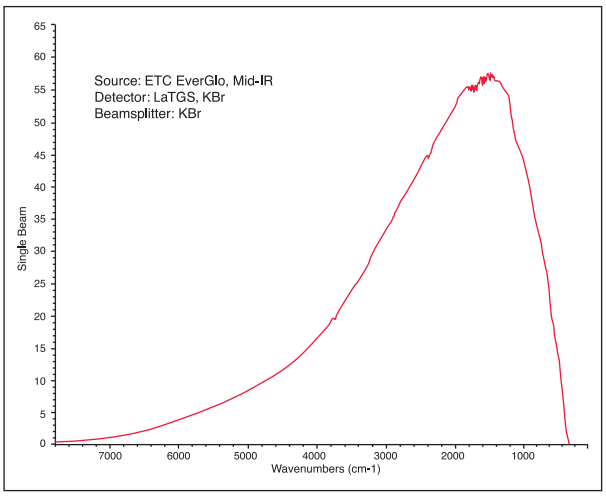

Figure 8

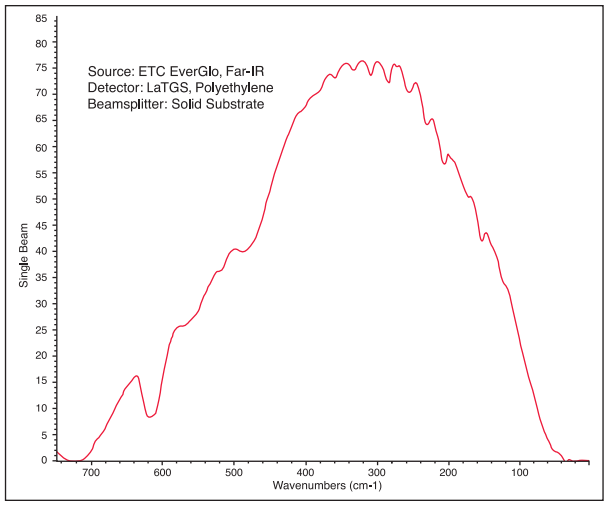

Figure 9

Lifetime and Serviceability

Another disadvantage of a traditional air-cooled source is its limited lifetime, which is typically 6-12 months. Source failure usually results in a service visit, downtime, and additional expense. The ETC EverGlo IR source has been extensively field tested and found to have a mean time between failure (MTBF) greater than five years. Traditional sources need to be manually aligned to the optics of the system. This would typically mean excess downtime, an expensive service call and, at minimum, poor reproducibility of results when system components were exchanged. Through precise manufacturing techniques, the ETC EverGlo IR source is user replaceable. It is pre-aligned and pinned-in-place like all of the components in the Nicolet FT-IR series spectrometers. The source can be installed by the user and quickly pinned into perfect alignment.

Summary

The advanced ETC EverGlo IR source with different operation modes provides a stronger, more reliable and stable energy over the 7400 – 50 cm^{-1} spectral region. It has significant potential to improve highly demanding experiments in many application fields. Its long lifetime and user-replaceable design virtually eliminates the downtime due to source failure.

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