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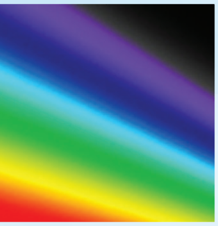
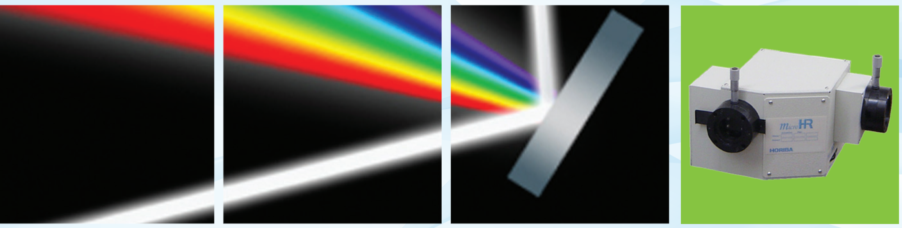


MicroHR

Absorption/Transmission Experiments OSD-MR-01

ELEMENTAL ANALYSIS
FLUORESCENCE
GRATINGS & OEM SPECTROMETERS
OPTICAL COMPONENTS
FORENSICS
PARTICLE CHARACTERIZATION
RAMAN
SPECTROSCOPIC ELLIPSOMETRY
SPR IMAGING



Easy-to-use spectrometer
Reliable results

Introduction

Absorption spectroscopy is a popular analytical tool to determine the presence of a particular chemical or biological substance in a sample, and often to quantify the amount of the substance present. Infrared and ultraviolet-visible spectroscopy are particularly common in analyses. Absorption spectroscopy is also employed in molecular and atomic physics, astronomical spectroscopy and remote sensing. For certain types of materials, the amount of light transmitted through a sample is commonly expressd as $\%T$, such as a transmission curve of an optical filter:

$$\%T = 100\% \times (I/I_0)$$

I is the intensity of light transmitted through the sample and I_0 is the intensity of light when the sample is removed. Absorbance (A) and transmittance $\%T$ are mathematically related:

$$A = 2 - \log_{10}(\%T)$$

Experiment

An automated MicroHR with a SampleMax and LSH-T250 tungsten-halogen light source and Synapse CCD and silicon photodiode performed transmittance measurements. Various lenses and lens positions were tested in order to determine the best configuration for a transmission measurement. The best results were obtained with a single 40 mm focal-length lens collimating the light hitting the sample, and a second 40 mm focal-length lens focusing the transmitted light into the spectrometer (Figure 1). A 1 mm height-limiter was used on the entrance slit, and, in this example, a 12 µm entrance slit width was used.

For transmission measurements, the sample was a 610 nm long-pass colored-glass filter. Transmission spectra were acquired with each of the two gratings: 1200 gr/mm at 500 nm and 600 gr/mm at 1000 nm.

Procedure

1. Verify the spectrometer's wavelength calibration and CCD alignment according to standard procedures.
2. Mount the SampleMax onto the MicroHR entrance slit, with a tungsten-halogen source (LSH-T250 or LSH-T100) along the spectrometer's optical axis, and set it up in Transmission mode (see Figure 1).
3. With no sample in position, set up a range-mode experiment from 400–800 nm. This is the uncorrected blank spectrum.
4. Measure a dark spectrum, which is used to calculate the "corrected" blank and sample spectra. Close the MicroHR entrance slit's height-limiter to block all light from entering the MicroHR, then run the same experiment as in step 3 (using the same integration time, etc.). If the system is configured with a CCD shutter, a dark spectrum may be automatically subtracted by checking

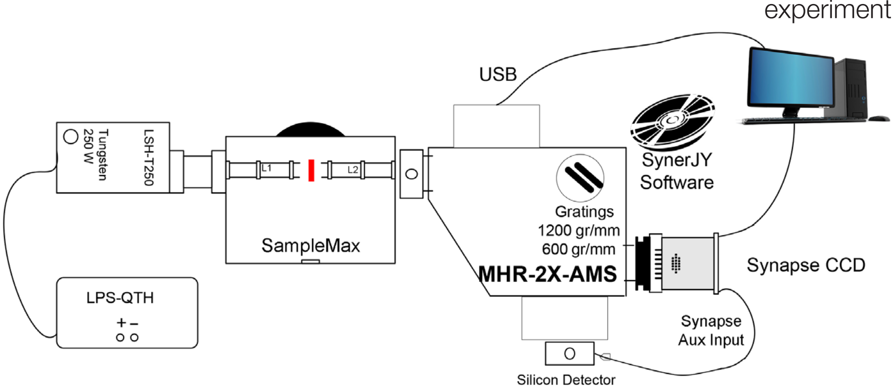


Figure 1. Instrument layout for absorbance/transmittance experiment using LSH, SampleMax, and MicroHR with Synapse CCD and silicon detector.

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the "dark subtract" checkbox in the software, yielding the corrected spectrum (for both blank and spectrum).

5. Blank (corrected) = (Step 3 result) – (Step 4 result). This corresponds to I_0.
6. Put the sample into position, open the height-limiter, and run the same experiment as in step 3.
7. Spectrum (corrected) = (Step 6 results) – (Step 4 result). This corresponds to I.
8. Calculate $\%T$ via

$$\%T = 100\% \times \text{spectrum}_{\text{corrected}}/\text{blank}_{\text{corrected}}$$

Convert to Absorbance units via

$$A = 2 - \log_{10}(\%T)$$

Note: You may do these calculations using the worksheets in Origin®, or exporting the data to Excel® or other programs.

You may use a similar procedure to acquire spectra using the silicon photodiode, via the Synapse Auxiliary Input channel as the data-acquisition controller.

Results

Absorption and transmission spectra were obtained using both MicroHR gratings. Figure 2 shows the transmission spectrum of a 610 nm long-pass filter using the 1200 gr/mm grating. The results are very similar to published transmission curves for this filter. Figures 3a and 3b show absorption and transmission spectra of holmium oxide measured with the 600 gr/mm grating, and match results from the literature.

Conclusions

A simple, modular system for measuring absorbance and transmittance was assembled using a MicroHR spectrometer, SampleMax sample compartment, LSH-T250 tungsten halogen source and appropriate detectors. For visible-wavelength measurements, a Synapse CCD and Si detector were used. This system provides convenient, accurate results. HORIBA offers a wide variety of detectors for measuring absorbance and transmittance for UV, visible, and IR spectral ranges.

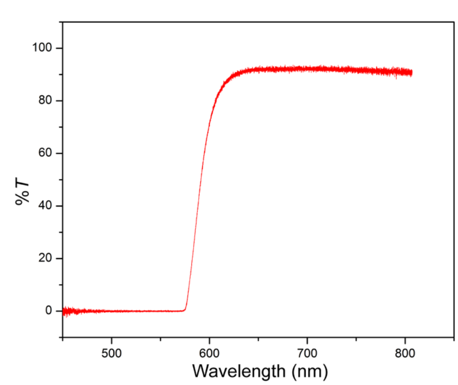

Figure 2. Transmission curve with 1200 gr/mm grating.

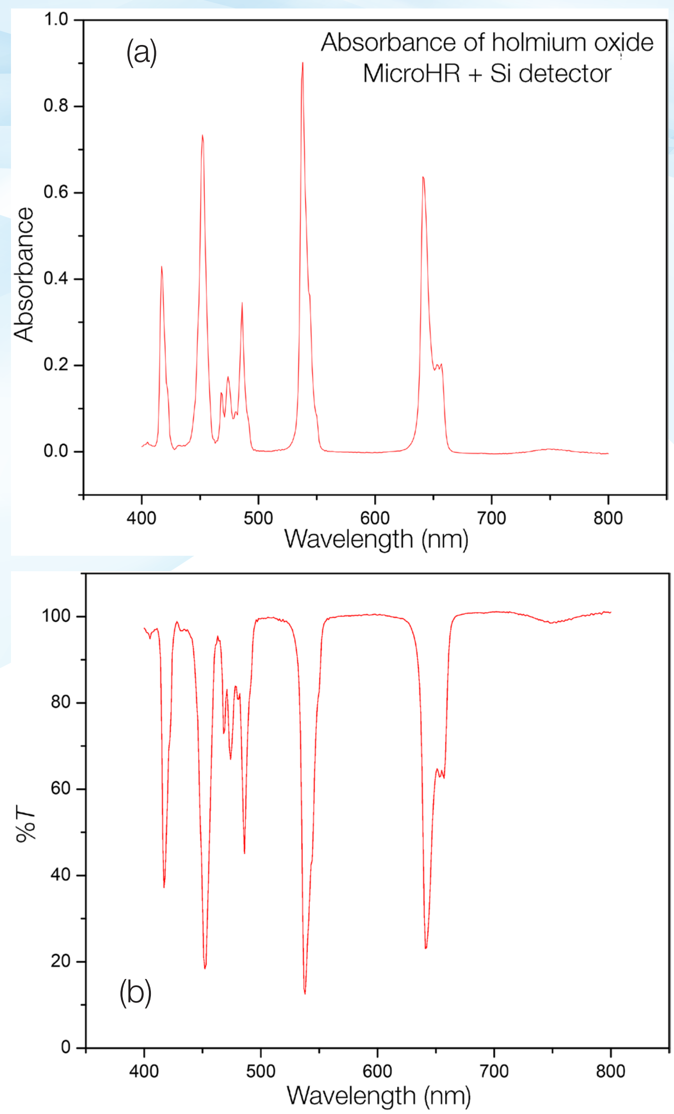

Figure 3a. Absorbance spectrum of holmium oxide using silicon photodiode; 3b: Transmittance spectrum of holmium oxide using silicon photodiode.

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