TECHNICAL NOTE

UV/Vis/NIR Spectroscopy

Linearity Measurements in the Visible Region on a LAMBDA 850+/1050+ Using Hellma Linearity Filters

Author:

Ian V. Bradley Ph.D.

PerkinElmer, Inc.
Chalfont Road
Seer Green
Beaconsfield, UK
HP9 2FX

Introduction

This note demonstrates the use of Hellma® linearity filters to study the linearity of the PerkinElmer® high performance LAMBDA™ instruments (LAMBDA 850+ and 1050+) in the visible region of the spectrum. Hellma® linearity filters are cut from the single block of "black" glass with increasing thickness, and polished to high tolerances, so that the thicknesses increase in equal steps. The glass is selected so that the steps in thickness of the filters (0.25 mm) result in approximately 1 A change in absorbance at 546 nm. Although the steps may not be exactly 1 A, the size of the increase in absorbance should be equal.

Experimental

Wavelength scans are taken on a LAMBDA 1050+ between 400-700 nm in 2 nm steps, with a slit width of 5 nm and a detector response time of 1 second. When required, signal to noise was optimized by attenuating the reference beam with internal attenuators. The LAMBDA 1050+ features automatic 2 A and 3 A attenuation which may be augmented by an additional magnetic attenuator on the sample compartment window as necessary. For all spectra,100% and 0% autozero correction scans were taken.

Results

The spectral data collected are displayed in Figure 1. There is no significant noise apparent on the data even for samples with absorbance greater than 8A.

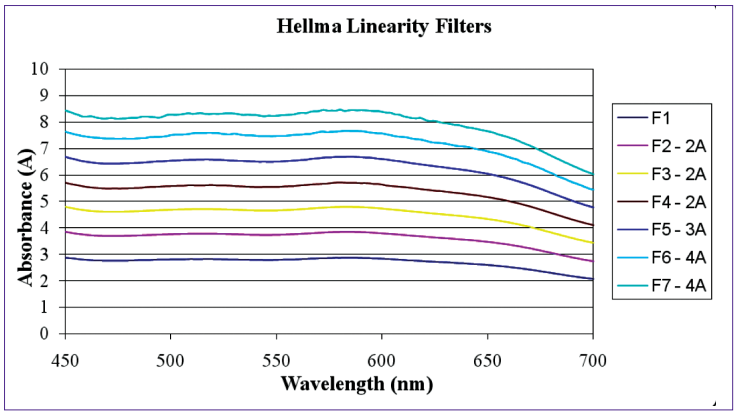

Figure 1. Scan taken with Hellma® filters (F1-F7 – See Table 1) between 400 and 700 nm with 2 nm steps, 5 nm slit and 1 second integration time. The attenuation used in the reference beam is shown alongside the filter number.

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Table 1. Hellma® filters used.

Filter number	Absorbance approx.	Thickness
666.034/1-F1	3 A	0.75 ±0.01 mm
666.034/1-F2	4 A	1.00 ±0.01 mm
666.034/1-F3	5 A	1.25 ±0.01 mm
666.034/1-F4	6 A	1.50 ±0.01 mm
666.034/1-F5	7 A	1.75 ±0.01 mm
666.034/1-F6	8 A	2.00 ±0.01 mm
666.034/1-F7	9 A	2.25 ±0.01 mm
666.034-F0	–	Blank

Figure 2 shows the data plotted against filter thickness. A least squares method is used to perform a linear fit to the data. The deviation from the linear fit is small, being <0.04 A. The tolerance on the thickness of the filters (±10 micrometers) is significantly greater than the deviation noted. The fitted line intersects the origin at 0.036 A, this is expected as reflection losses at the two surfaces of the filter are not accounted for in this experiment. The measured reflection loss per surface is 4% T, which is expected for this type of glass.

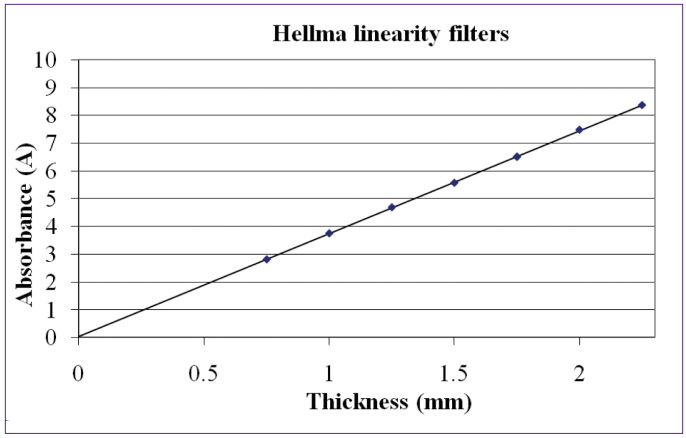

Figure 2. Measured absorbance of Hellma® filters against filter thickness.

Conclusion

High quality spectral data have been obtained for samples greater than 8 A. The absorbance linearity of the data is very good with only small deviation from the linear fit >0.04 A, and these errors can be attributed to the thickness tolerance of the Hellma® linearity filters.

These results were taken with a LAMBDA 1050+ spectrometer, but equivalent results can be obtained with all instruments in the LAMBDA 850+/1050+ series. The LAMBDA 1050+ provides enhanced functionality for high absorbance samples due to its higher light throughput (source doubling mirror) and built-in automated attenuators up to 3 A. The LAMBDA 1050+ can measure samples with attenuation values approaching 8 A without use of additional manual attenuators.

PerkinElmer, Inc.
940 Winter Street
Waltham, MA 02451 USA
P: (800) 762-4000 or
(+1) 203-925-4602
www.perkinelmer.com

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