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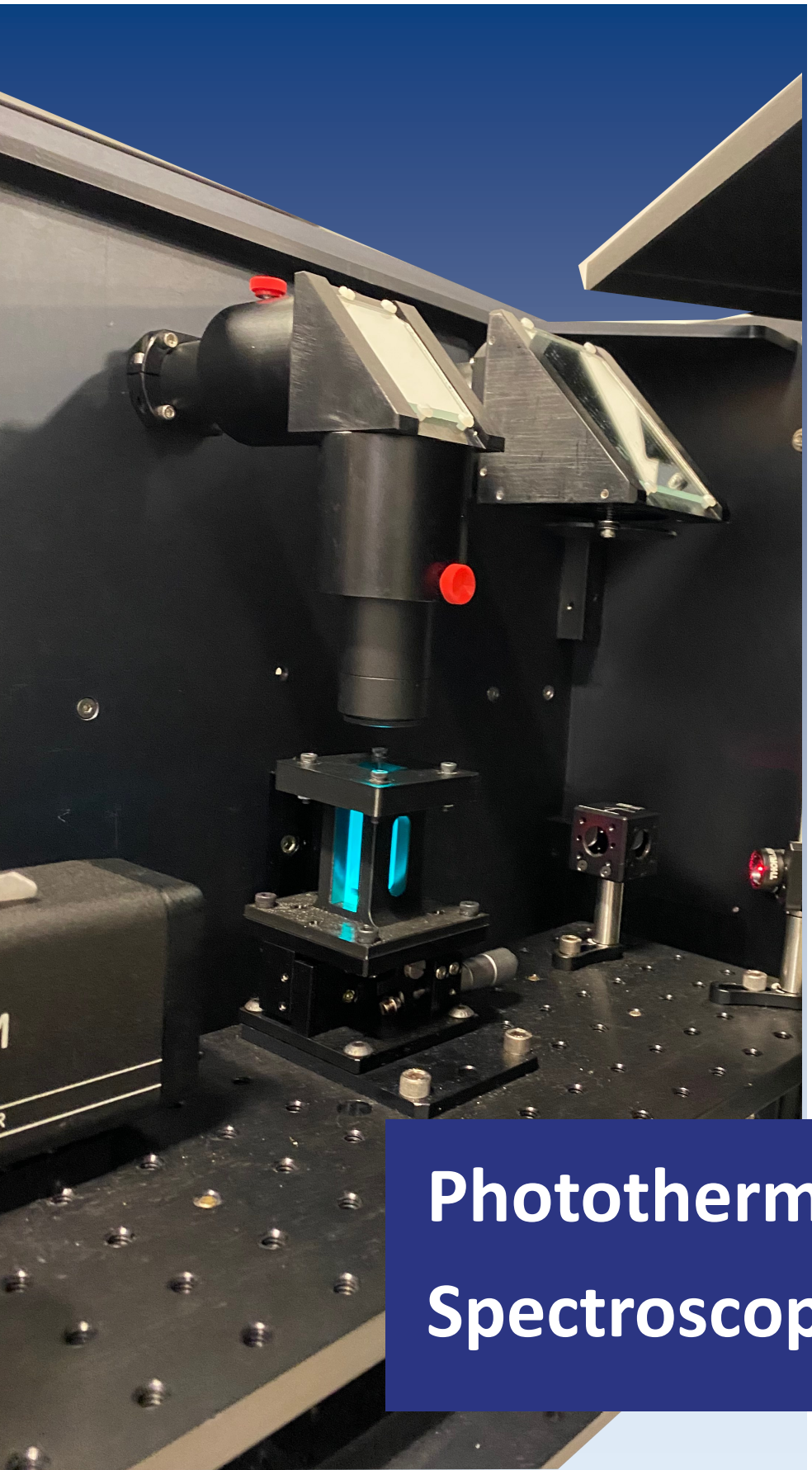
Making Light Work Better



Applications

- Photothermal deflection spectroscopy

Features

- Spectral range 250-2500 nm (upgradeable)
- Monochromatic light power up to 125 mW
- Effective PTDS measurements in Vis and NIR regions
- Can be installed in all Sciencetech PTS system

Photothermal Deflection Spectroscopy (PTDS)

June 2021 08 V1.02

Photothermal Deflection System

OVERVIEW

The Sciencetech Photothermal Deflection Spectroscopy module (PTDS) can be added to any standard PTS system.

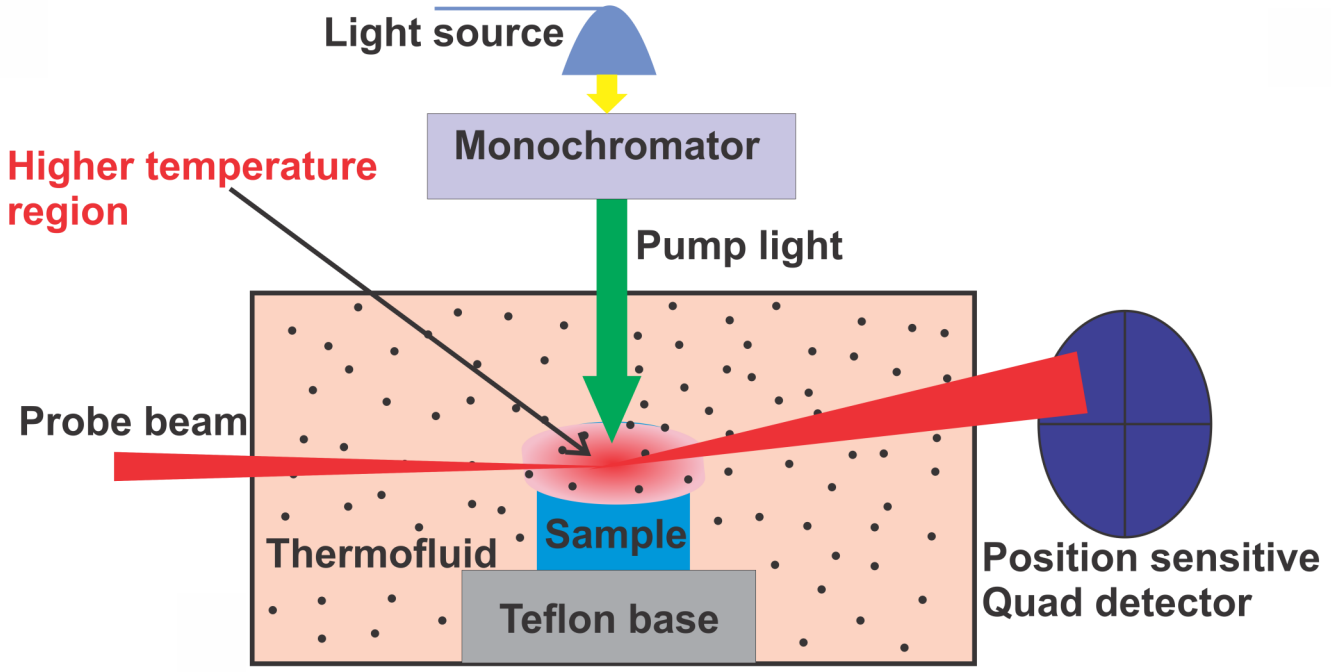
The PTDS module uses the transverse photo-thermal deflection spectroscopy technique[1] to measure relative absorbance of a material. An optically absorptive sample is placed in the cuvette containing the thermofluid, the sample absorbs the pump light coming from the main lamp output of the PTS system.

Absorption of the pump light heats the sample and causes a change in the index of refraction of the thermofluid, which deflects the probe laser by some amount related to the amount of radiation absorbed. A position sensitive detector and lock-in amplifier are employed to record the deflection level.

The standard PTS tunable light source utilizes a Xenon arc lamp which provides radiation from 250-2500nm. In practice PTDS measurements are best realized in the region where the light source provides the highest flux and the sample absorbs strongly. For most samples this is the VIS and NIR regions.

With the PTDS technique it is possible to determine the absolute absorption coefficient if: 1) Sample is thermally thick for the given measurement parameters[2]. 2) An absorption coefficient standard is available that is also thermally thick for the given measurement parameters 3) Specific material constants are available to perform the calculation. Required material constants for the sample and standard are: thermal conductivity, thermal diffusivity and thermal diffusion length.

Additionally the thermal diffusivity of the thermofluid used must be known.



1– W. B. Jackson, et al. , *Applied optics* 20(8), 1333-1344 (1981)

2- A. Mandelis, Journal of Applied Physics 54(6), 3404-3409(1983)

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Photothermal Deflection System

SPECIFICATIONS

Probe beam	Lumentum HeNe Laser ·Wavelength (nm): 632.8 ·Maximum power : <1mW ·Power Stability (%): ±2.5 ·Spatial Mode: >95% TEM00 ·Warm-Up Time (minutes): 20 ·Beam Diameter : 0.48 ·Operating Lifetime (hours): 1200
Position Sensitive Quadrature Photodiode	·7.98mm diameter , 4 × 12.3 mm2 active area ·Responsivity : VR = 0V; λ = 633 nm , VR = 0V; λ = 900 nm ·DC Voltage Input 9-24V ·Dark Current at VR= 10V , 2nA
Pump beam (PTS system) **	150 W Xenon short arc lamp, 1200 hour average lifetime 250 - 2500 nm tuning/scanning range (Xenon) 1/4 m Czerny-Turner monochromator with an adjustable bandpass of 0.2 to 24 nm Motorized triple grating turret system (2 gratings included) Adjustable beam size, down to 0.1 cm × 0.1 cm Includes hard coated order sorting filters
Photothermal deflection measurement spectral range	Strongly depends on sample absorption, for most samples this is the VIS and NIR regions.

** Upgradable based on PTS system

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Photothermal Deflection System
ABSORPTION COEFFICIENT

Presented here is a data set for absorptive neutral density filters OD0.6, and OD0.4.

Name	Optical Density	Manufacturer	Manufacturer Part No.	Thickness	Material
OD0.6	0.6	Edmund Optics	46-220	2.56 mm	Hoya ND-25
OD0.4	0.4	Edmund Optics	46-219	2.35 mm	Hoya ND-25

Both ND filters are thermally thick , required constants are as follow:

Symbol	REQUIRED CONSTANTS	UNITS	VALUE
k	SAMPLE Thermal Conductivity	W/(mm K)	0.800
F	FLUID Thermal Diffusivity	mm^2/s	0.031
d	SAMPLE Thermal Diffusivity	mm^2/s	0.340
μ	SAMPLE Thermal Diffusion Length	Mm	0.266
K	STANDARD Thermal Conductivity	W/(mm K)	0.800
D	STANDARD Thermal Diffusivity	mm^2/s	0.340
ʊ	STANDARD Thermal Diffusion Length	mm	0.266

The last table presents the absorption coefficient of the unknown sample. To calculate the absorption coefficient of the sample (α), one should enter the standard known absorption coefficient (Λ), along with the raw PDS signal for a sample (p) and standard (P) into the provided Excel calculator. The last table (symbol, α), presents the absorption coefficient of the unknown sample. The green highlighted column at the far-right hand is the final calculated absorption coefficient of (OD 0.4) for the values of wave-length range (first column), correction factor (second column) ,absorption deflection signal (PDS signal), and the known absorption coefficient values for the standard sample (OD 0.6) .

Symbol, Λ	
STANDARD ABSORPTION COEFFICIENT	
Wavelength (nm)	Abs Coeff (mm-1)
OD0.6 KNOWN	
500.000	0.498
519.992	0.491
540.000	0.477
559.997	0.466
579.997	0.493
599.994	0.520

Symbol, p	
SAMPLE PDS SIGNAL	
Wavelength (nm)	PDS Signal (V)
OD0.4 AVG	
500.000	3.46E-02
519.992	3.44E-02
540.000	3.15E-02
559.997	2.92E-02
579.997	2.79E-02
599.994	2.51E-02

Symbol, P	
STANDARD PDS SIGNAL	
Wavelength (nm)	PDS Signal (V)
OD0.6	
500.000	4.33E-02
519.992	4.32E-02
540.000	3.83E-02
559.997	3.54E-02
579.997	3.40E-02
599.994	3.11E-02

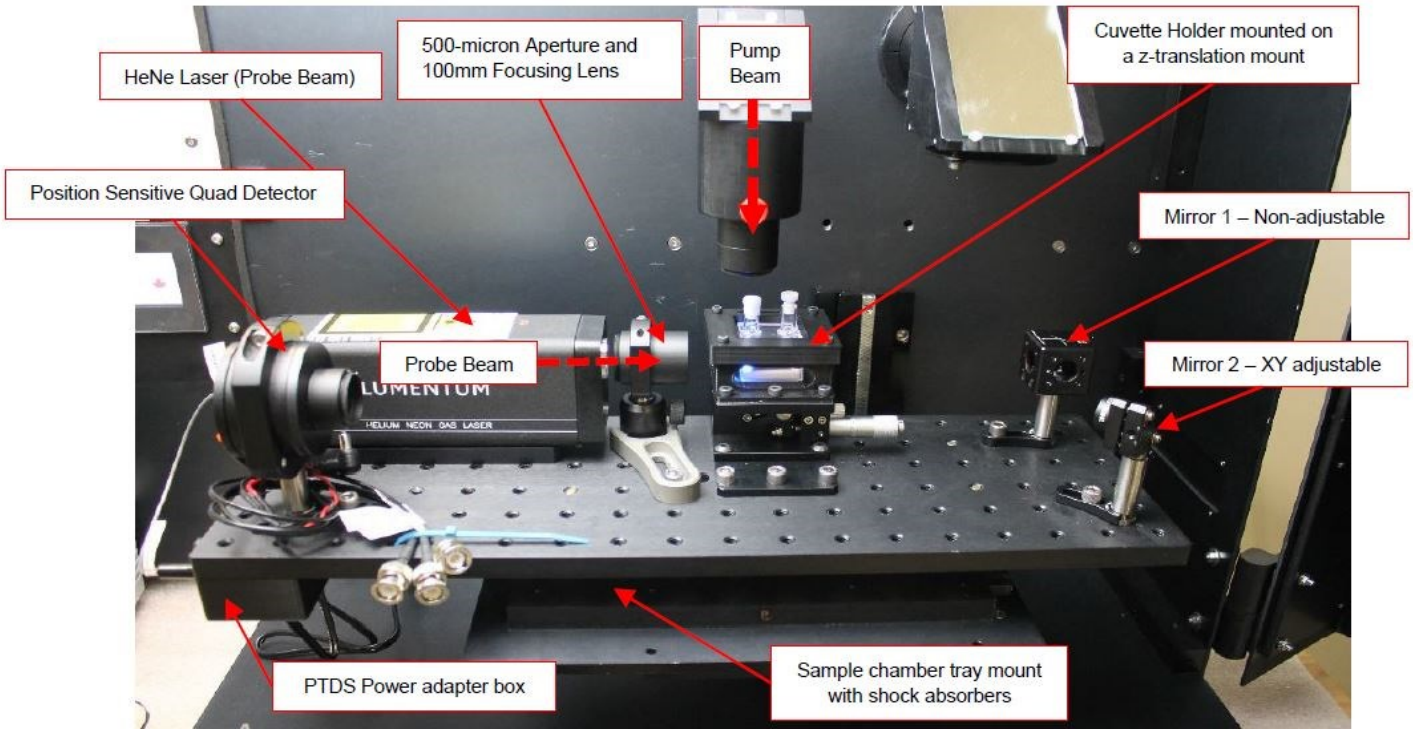
Symbol, α			
SAMPLE ABSORPTION COEFFICIENT			
Wavelength (nm)	step one, C	Abs Coeff (mm-1)	Abs Coeff (mm-1)
OD0.4 AVG, OD0.6 STD			
500.000	5.945	-0.356	0.393
519.992	5.882	-0.350	0.386
540.000	6.448	-0.351	0.388
559.997	6.818	-0.344	0.379
579.997	7.492	-0.361	0.399
599.994	8.622	-0.373	0.414

Photothermal Deflection System

SAMPLE CHAMBER

Photothermal deflection system add-on installed in PTS sample chamber has four major components:

- The probe beam source,
- The cuvette holder mounted on a z-translation stage,
- Turning mirrors to relay the beam (UV-Enhanced Aluminum mirrors)
- The position sensitive quad detector



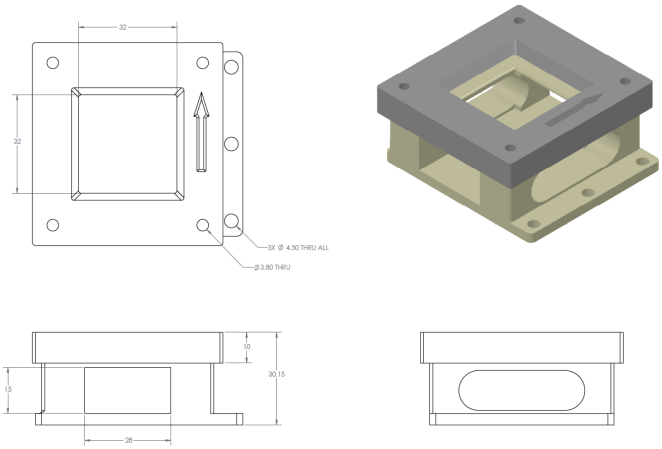
Photothermal Deflection System

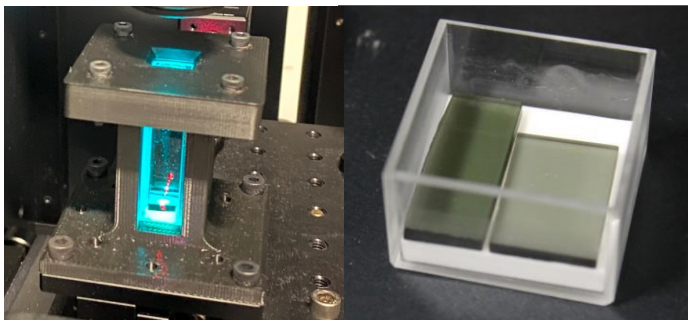
ACCESSORIES

Cuvette Holder and Cuvettes

The cuvette holder is a custom-made part that holds the cuvette assembly securely in place. It consists of a detachable lid cover with an arrow on the lid pointing towards the HeNe probe beam direction, and a 3-D cage mount with windows on all four sides to give optical access for alignment and measurements.

Model	Sample max size(mm^3)
PDS-CUV-STD	Standard-Sized cuvettes
PDS-CUV-32 (consume made cuvettes)	32×32×10





Thermofluid: 3M Flourinert

**Due to shipment restriction, the thermofluid should be purchased separately by the customer