ULSAN NATIONAL INSTITUTE OF SCIENCE AND TECHNOLOGY

UV-Vis-NIR

1. Syllabus

UV-Vis-NIR Training, 2022

Qualification for UV-Vis-NIR operation

1. UV-Vis-NIR self-user training

1) Theory class (UV-Vis-NIR manager Mi Sun Cho, 4034)

2) Operation class (UV-Vis-NIR manager Mi Sun Cho, 4034)

2. Practice UV-Vis-NIR yourself

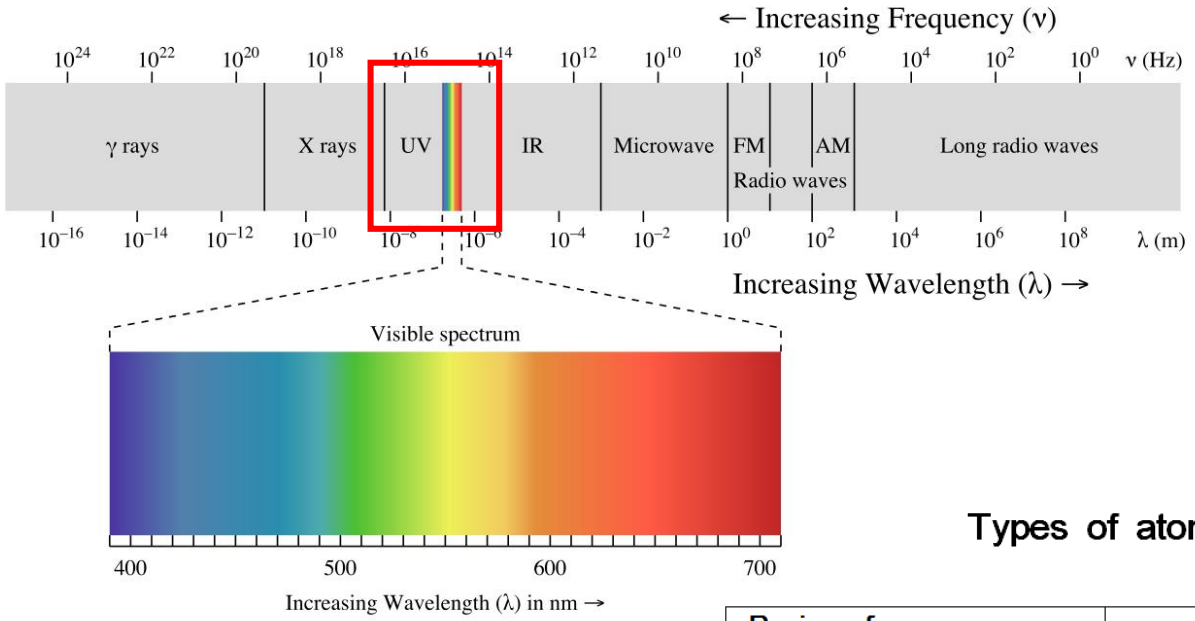
- Each person practice with manager or self-user in your lab 2 times.
- Please contact manager or book a training time with self-user in your lab
  (Leave a “trainee name” practice in booking message.)

3. Attend the UV-Vis-NIR test

- 20 min.test
- Explain about UV-Vis-NIR and measurement methods.
- Sample measurement with %T or Abs or %R

2. Basic Principles

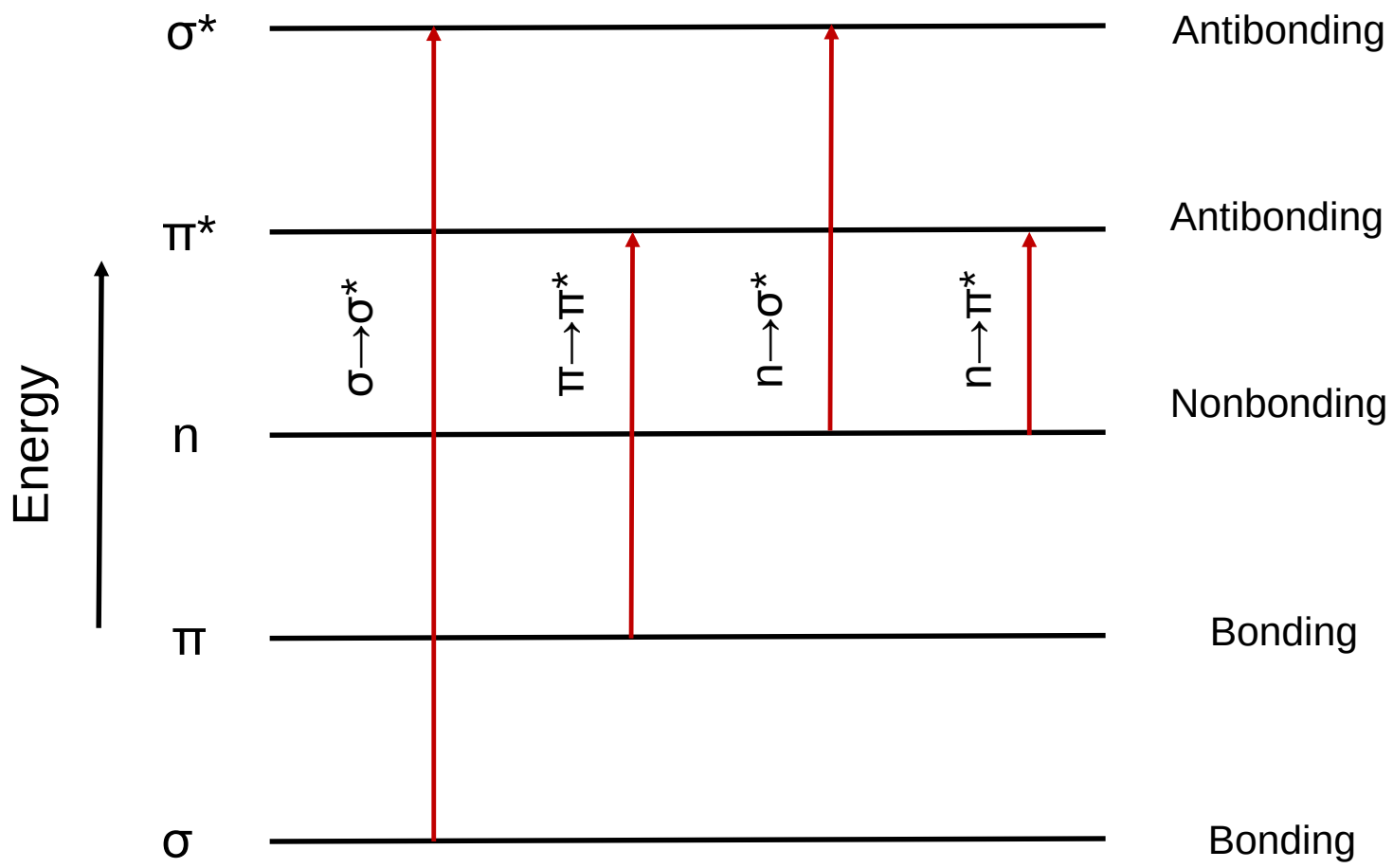
Electromagnetic spectrum



Types of atomic & molecular transition

Region of electromagnetic spectrum	Interaction	Spectroscopic technique
γ-ray	Nuclear	Mössbauer spectroscopy
χ-ray	Core-level electron	X-ray absorption spectroscopy
Ultraviolet (UV)	Valence electron	UV/Vis spectroscopy
Visible (Vis)		
Infrared (IR)	Molecular vibration	IR spectroscopy Raman spectroscopy
Microwave	Molecular rotation	Microwave spectroscopy
Radio-wave	Nuclear spin	Nuclear magnetic resonance spectroscopy

Electron transitions



Electron transitions

1. $\sigma \rightarrow \sigma^*$
   - UV photon required, high energy
     - Methane at 125 nm
     - Ethane at 135 nm

2. $n \rightarrow \sigma^*$
   - Saturated compounds with unshared e^-
     - Absorption between 150 nm to 250 nm
     - ε between 100 and 3000 $Lcm^{-1}mol^{-1}$
     - Shifts to shorter wavelengths with polar solvents

   - Halogens, N, O, S

Electron transitions

3. $n \rightarrow \pi^*$, $\pi \rightarrow \pi^*$
   - Organic compounds, wavelengths 200 to 700 nm

   - Requires unsaturated groups
     - $n \rightarrow \pi^*$, low ε (10 to 100)
       shorter wavelengths

     - $\pi \rightarrow \pi^*$, higher ε (1000 to 10000)

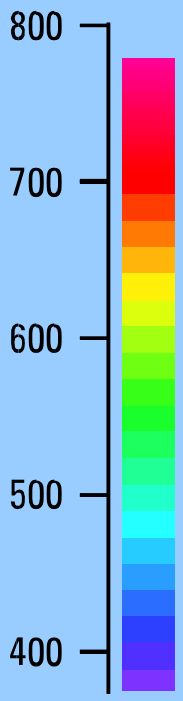
Identification-spectra and structure

- A saturated hydrocarbon produces a compound with absorption between 185 and 1000 nm.
- The presence of an absorbance band is a good indicator of the presence of a chromophore.

Selected chromophores and their absorbance maxima

Chromophore	Formula	Example	γ_{max} (nm)
Carbonyl (ketone)	RR'C=O	Acetone	271
Carbonyl (aldehyde)	RHC=O	Acetaldehyde	293
Carboxyl	RCOOH	Acetic acid	204
Amide	$RCONH_2$	Acetamide	208
Ethylene	RCH=CHR	Ethylene	193
Acetylene	RC=CR	Acetylene	173
Nitrile	RC=N	Acetonitrile	<160
Nitro	RNO_2	Nitromethane	271

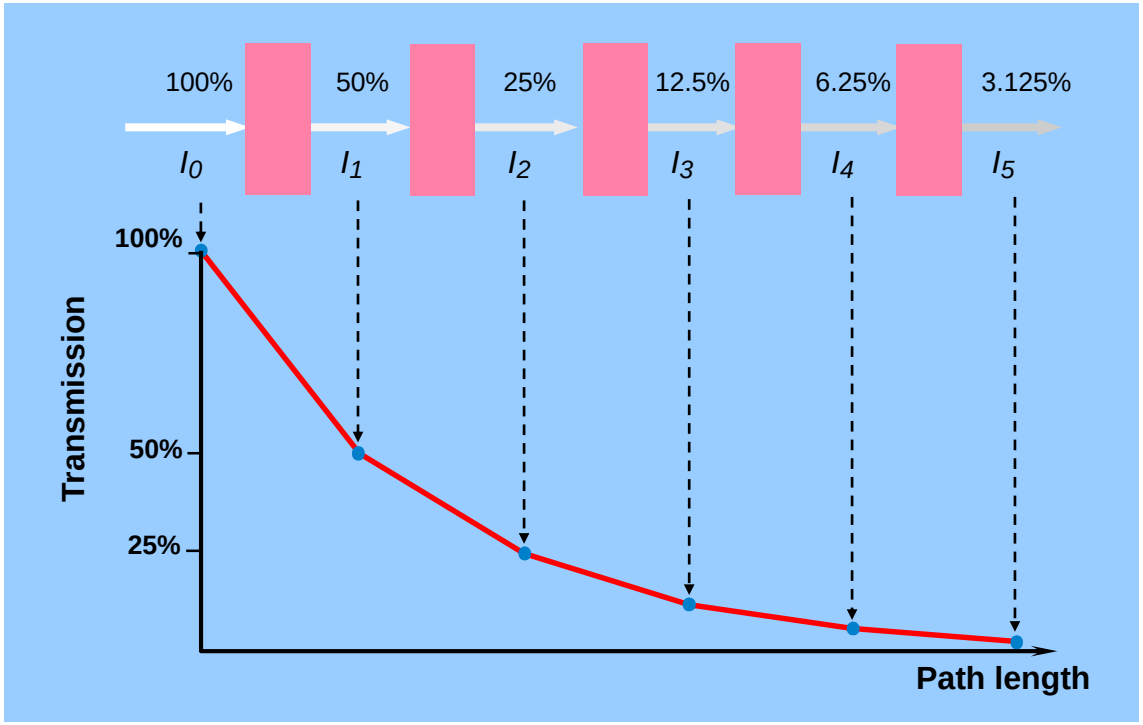
Absorbance and complementary color



Wavelength [nm]	Absorbed color	Complementary color
650-780	red	blue-green
595-650	orange	greenish blue
560-595	yellow-green	purple
500-560	green	red-purple
490-500	bluish green	red
480-490	greenish blue	orange
435-480	blue	yellow
380-435	violet	yellow-green

Bougert–Lambert law

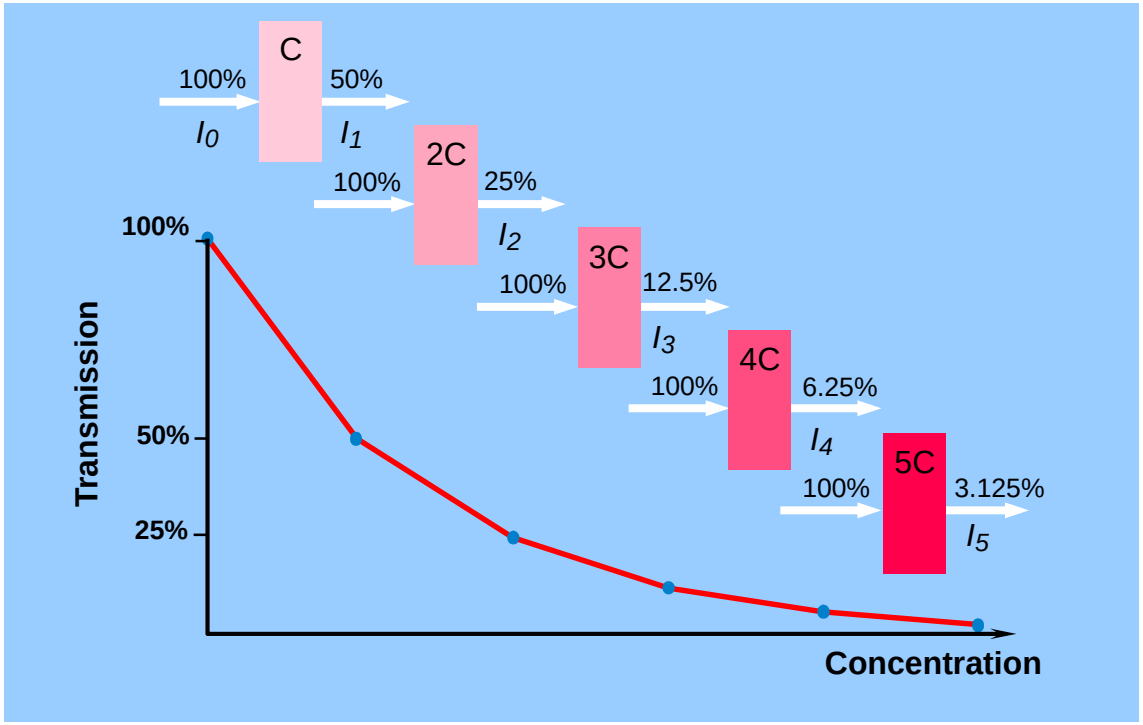
Transmission *vs* Path length



$$T = I/I_0$$
$$= e^{-Kc}$$

Where:
T = transmission
I_o = incident intensity
I = transmitted intensity
K = a constant
c = concentration

Transmission *vs* Concentration



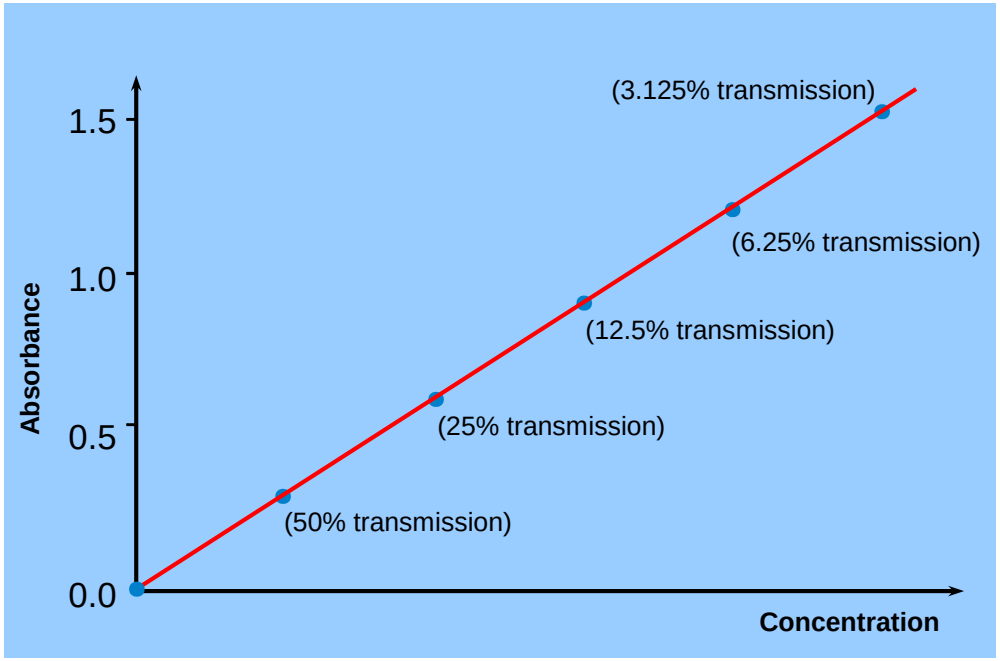
$$T = I/I_0$$
$$= e^{-Kc}$$

Where:
T = transmission
I_o = incident intensity
I = transmitted intensity
K = a constant
c = concentration

Beers-Bougert-Lambert Law

Absorbance *vs* Concentration

$$A = - \log T$$
$$= - \log (I/I_0)$$
$$= \log (I_0/I)$$
$$= \varepsilon bc$$



Absorbance is the negative logarithm of **Transmittance** and has a linear relation to concentration and path length

Where:
T = transmission
I_o = incident intensity
I = transmitted intensity
k = a constant
b = path length
c = concentration

Absorbance and transmission

Transmission $T = I/I_o$

% Transmission $\%\ T = I/I_o * 100$

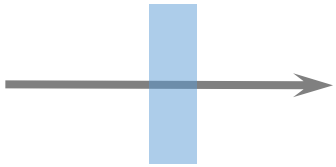
Absorbance $Abs = -\log(T)$

Transmission	%T	Absorbance	
1	100 %	0	
0.1	10 %	1	
0.01	1 %	2	
0.001	0.1 %	3	
0.0001	0.01 %	4	Maximum Value

Types of interactions

Transmission

- through transparent materials

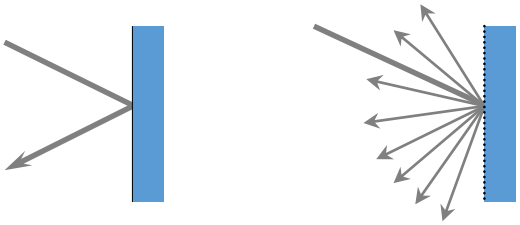


Absorption

- by solids or semi-transparent materials

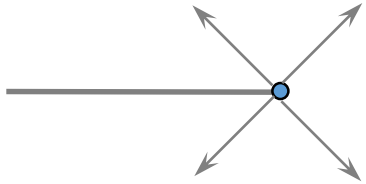
Reflectance

- “specular” from mirror surfaces
- “diffuse” from rough surfaces



Scattering

- from small particles



Energy band gap (Tauc plot)

Optical absorption coefficient

(T)

Alpha = 1/d * ln (1/T)

where ***(d)*** is the sample thickness and ***(T)*** is the transmittance,

(T/R)

$$\alpha(\lambda) = \left(\frac{1}{t}\right) ln \left[\frac{(1-R)^2}{2T} + \sqrt{\frac{(1-R)^4}{4T^2} + R^2}\right]$$

Tauc plot

$$\alpha^*(h\nu) = \alpha_o [(h\nu) - E_g]^n$$

where α_o is a constant and sometimes called the band tailing parameter and it is an energy independent constant, and E_g is the optical energy gap, which situated between the localized states near the mobility edges according to the density of states model proposed by ***Mott and Davis.***

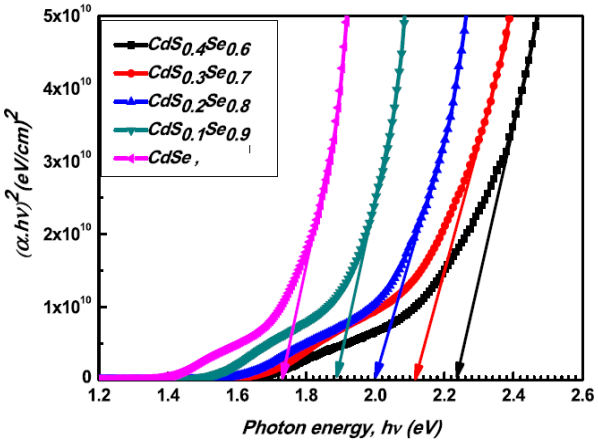
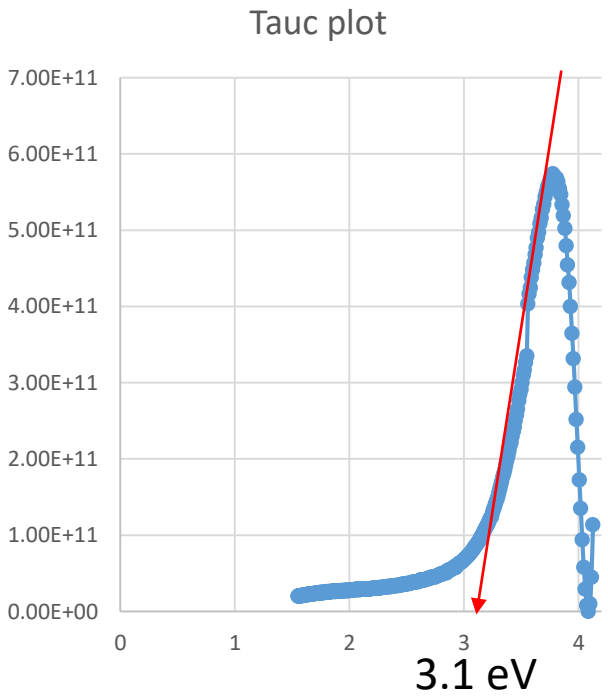


Fig. 6. Dependence of $(\alpha h\nu)^2$ of chalcogenide CdS_xSe_{1-x} thin films upon the incident photon energy ($h\nu$).



Energy band gap (Kubelka-munk equation)

The Kubelka-Munk Theory of Reflectance

This theory was originally developed for paint films but works quite well in many circumstances for paper. It is not, however, terribly good for dyed papers (or very dark, unbleached papers) when light absorption reaches a high level. A limiting assumption is that the particles making up the layer must be much smaller than the total thickness. Both absorbing and scattering media must be uniformly distributed through the sheet. Ideally, illumination should be with diffuse monochromatic light and observation should be of the diffuse reflectance of the paper. The theory works best for optically thick materials where > 50 % of light is reflected and < 20 % is transmitted.

Kubelka and Munk
Zeit. Für Tekn. Physik, 12, p593 (1931).

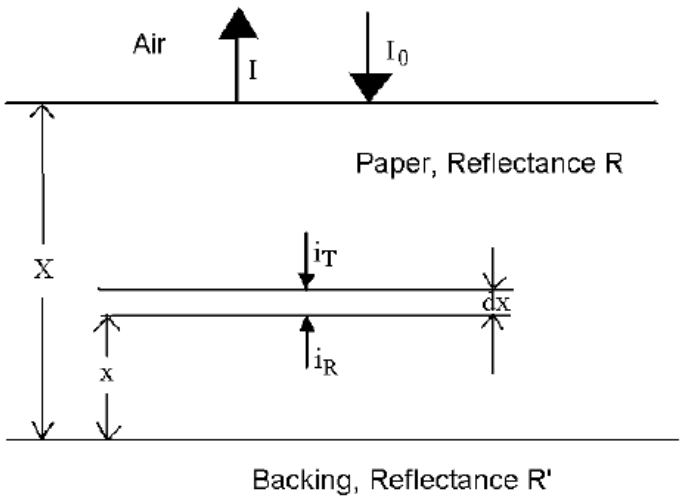
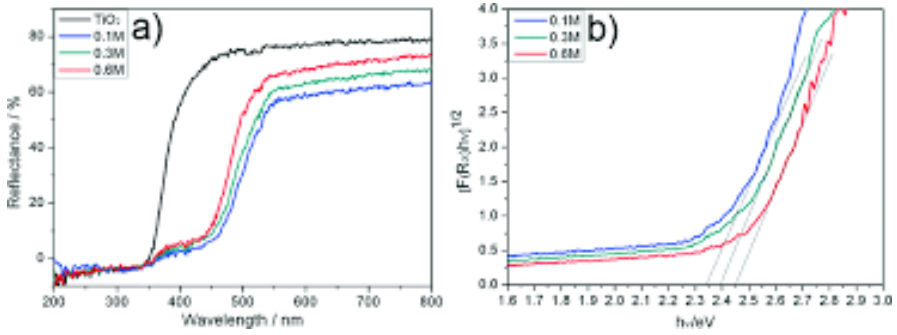
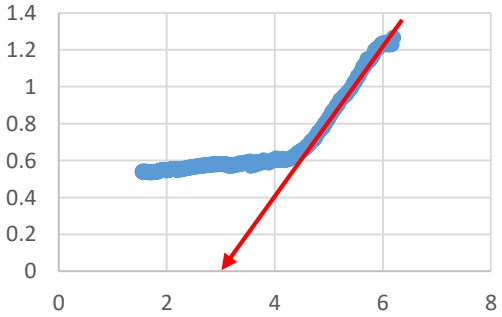


Figure 1 Consider light of intensity I_0 incident on a non-glossy piece of paper of thickness X and reflectance R. Behind this piece of paper is a surface of reflectance R'. The light which re-emerges from the top surface of the paper after scattering, absorption or transmission has intensity I. At a distance x from the bottom surface of the paper there is a thin lamina of thickness dx and scattered light is incident on it which is travelling both upwards and downwards through it with intensities i_R and i_T, respectively.

$$F(R) = \frac{(1-R)^2}{2R}$$



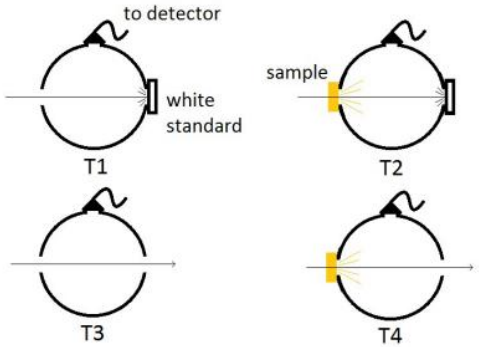
Kubelka-Munk equation

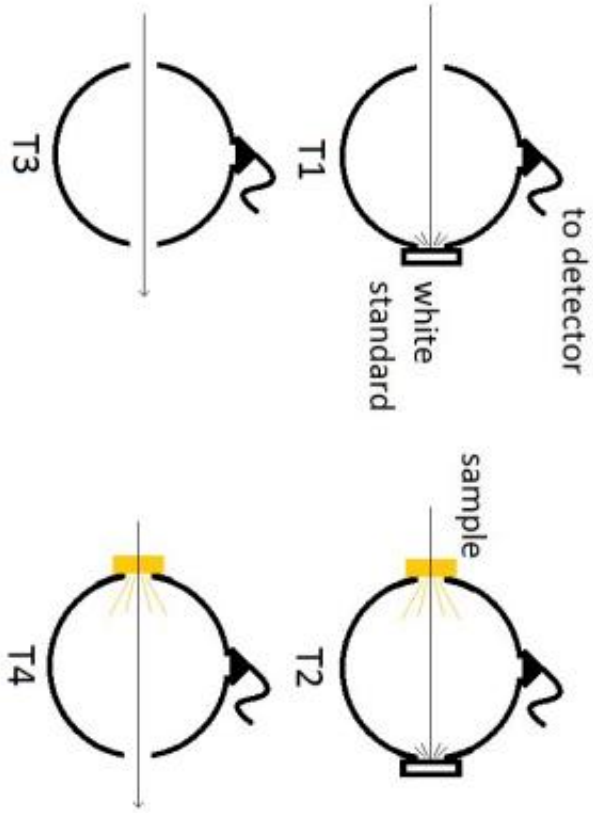


Haze

Haze and transmittance measurement

Haze measurement requires four scans using the configurations shown in the figure. In configuration T1 exit from an integrating sphere is closed with white standard, while in configuration T2 additionally a sample is placed at the entrance to the sphere. In configuration T3 light can pass through the sphere undisturbed and in configuration T4 it is scattered by the sample at the entrance to the sphere.

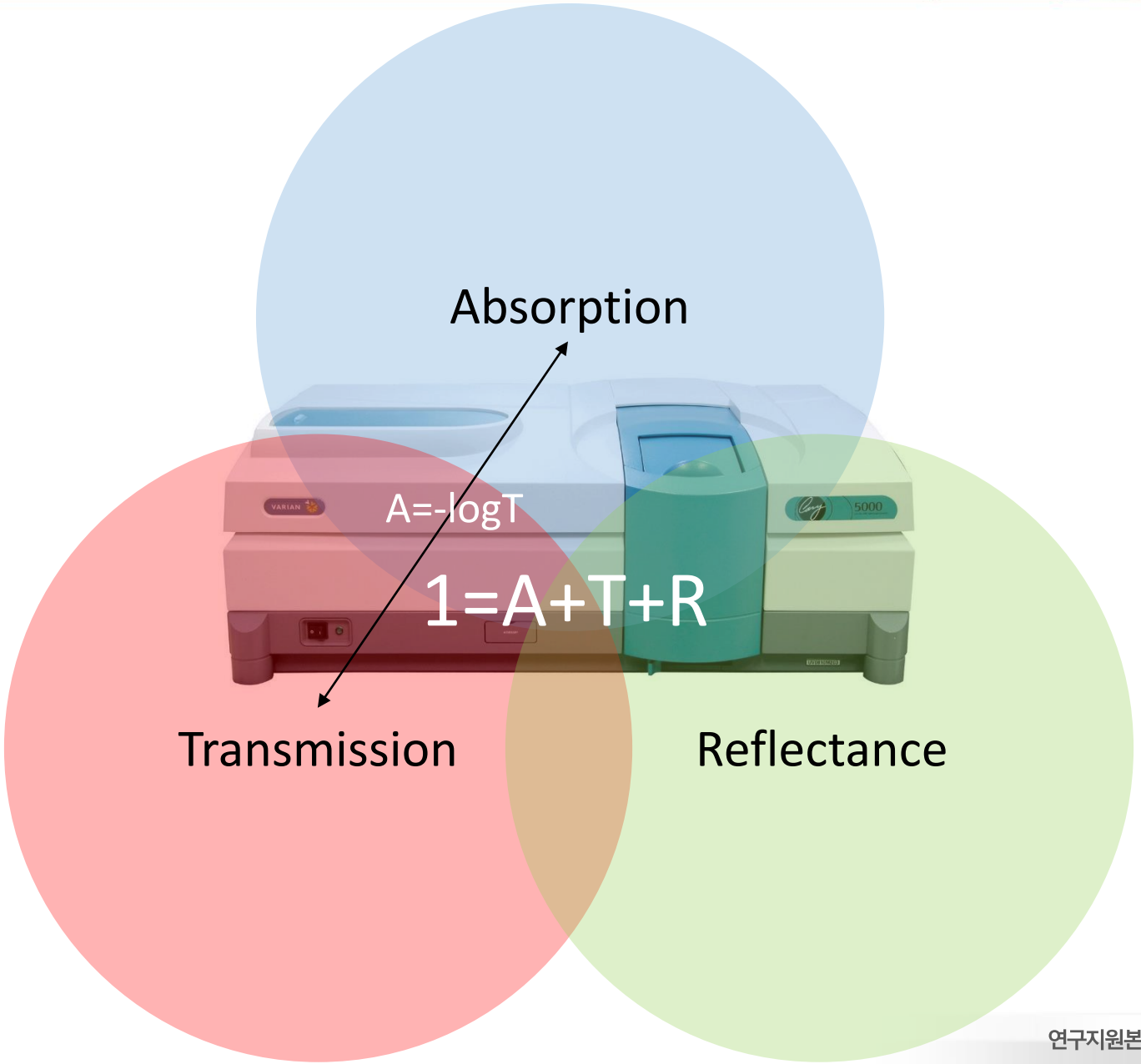


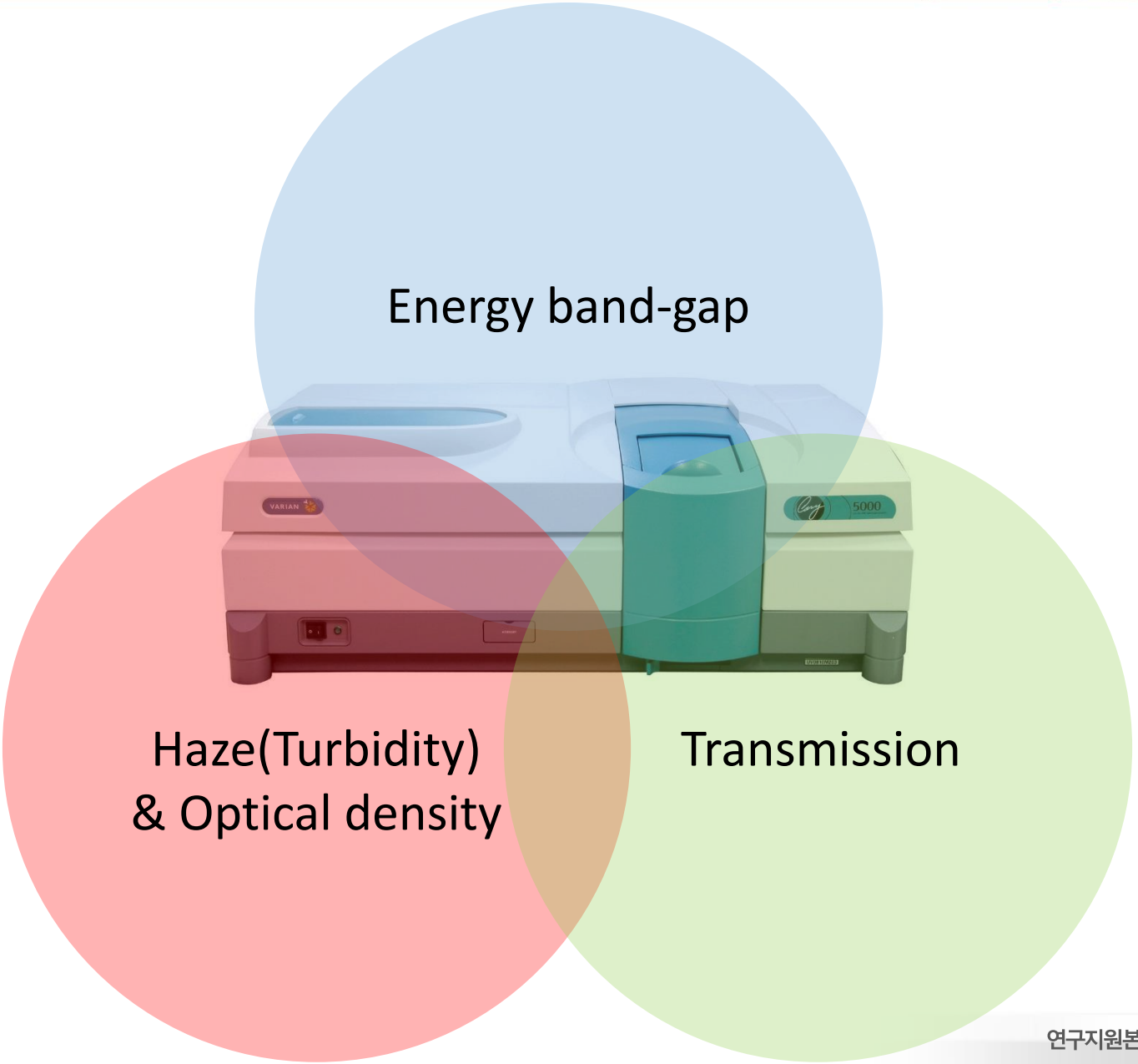


Since our discs are not only scatters but also emitters,we decided to integrate scans in two spectral ranges: all visible range (380-780nm) and the range where samples do not absorb (600-780nm). Integrated area under each spectrum was used in the formula below. Measurements were performed for number of discs in a stack ranging from one to five.

$$Haze = \left(\frac{T4}{T2} - \frac{T3}{T1} \right) \cdot 100\%$$

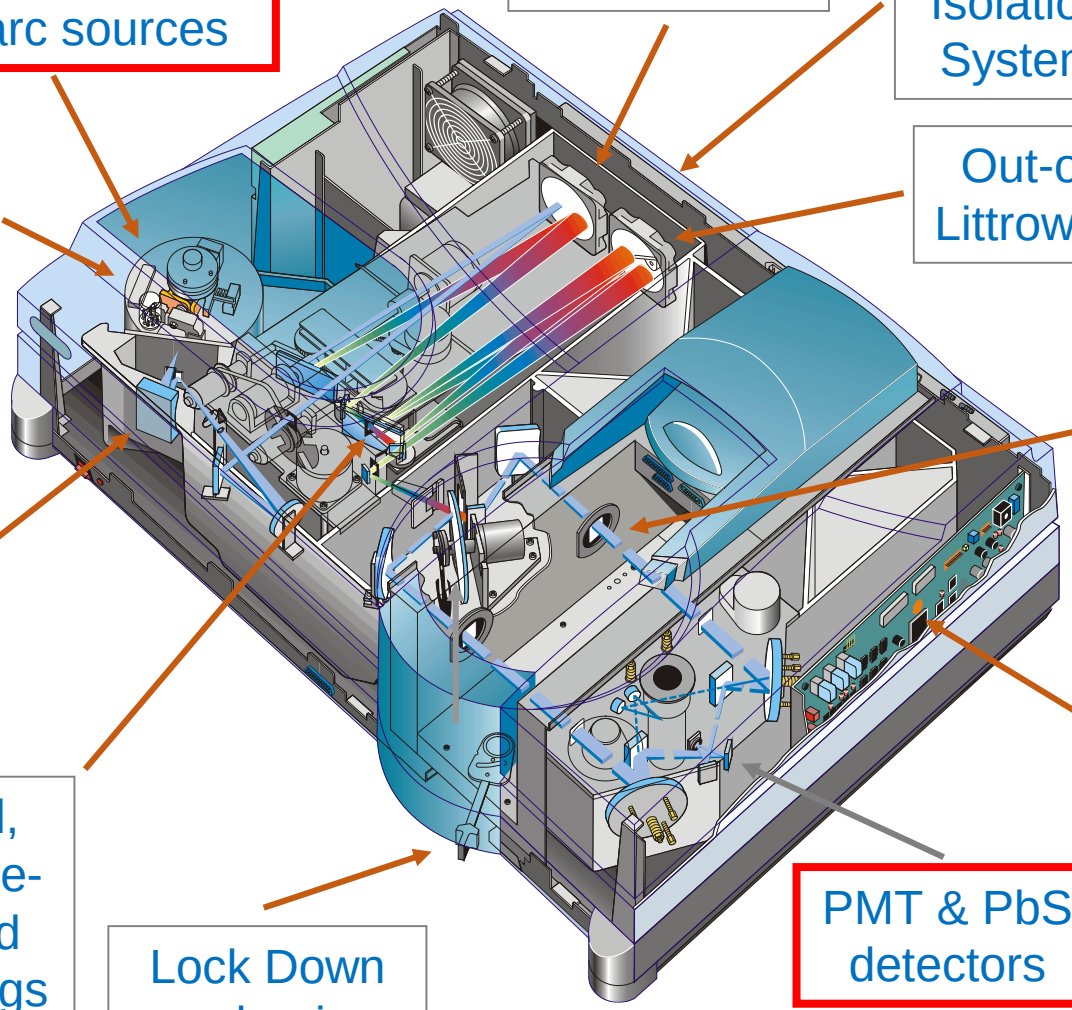
Measurement mode




Energy band-gap
Haze(Turbidity)
& Optical density
Transmission

3. Hardware

Instrument specifications



Tungsten halogen & D_2 arc sources

Silica coated optics throughout

Optical Isolation System

'Plug & Go'™ lamp management

Out-of-plane double Littrow monochromator

Large sample compartment with removable floor

Schwarzschild coupling optics for maximum light throughput

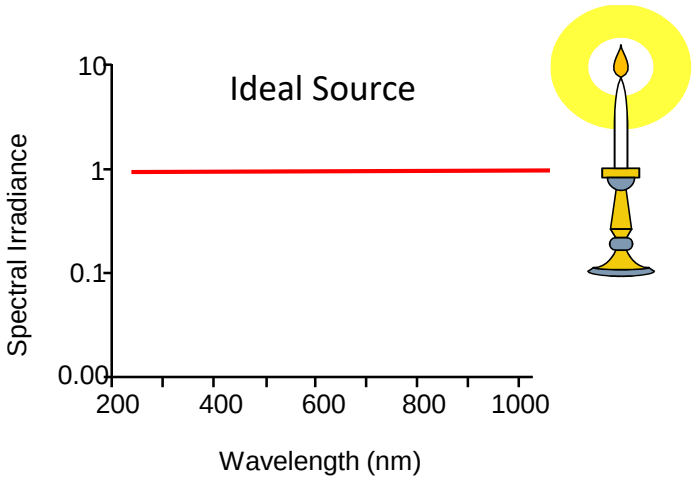
Advanced electronic design

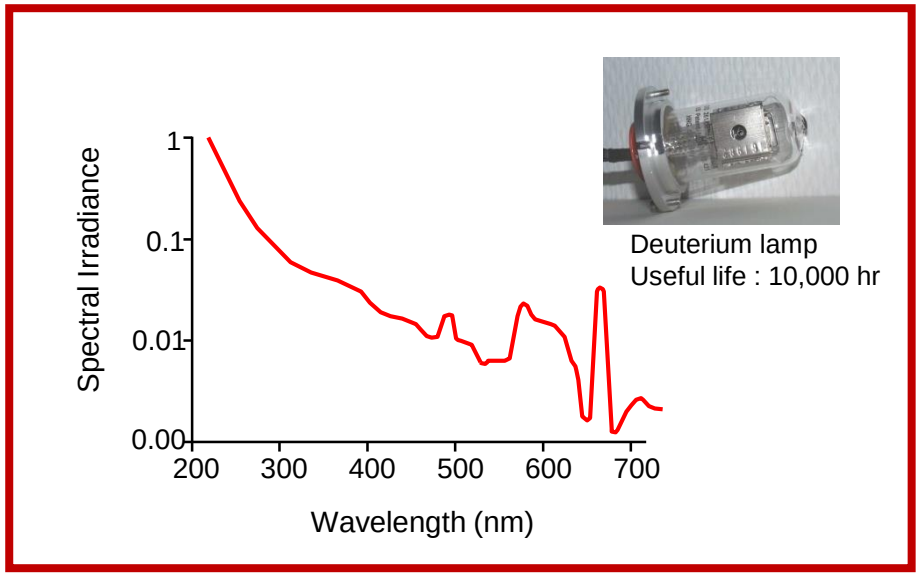
Dual, double-sided gratings

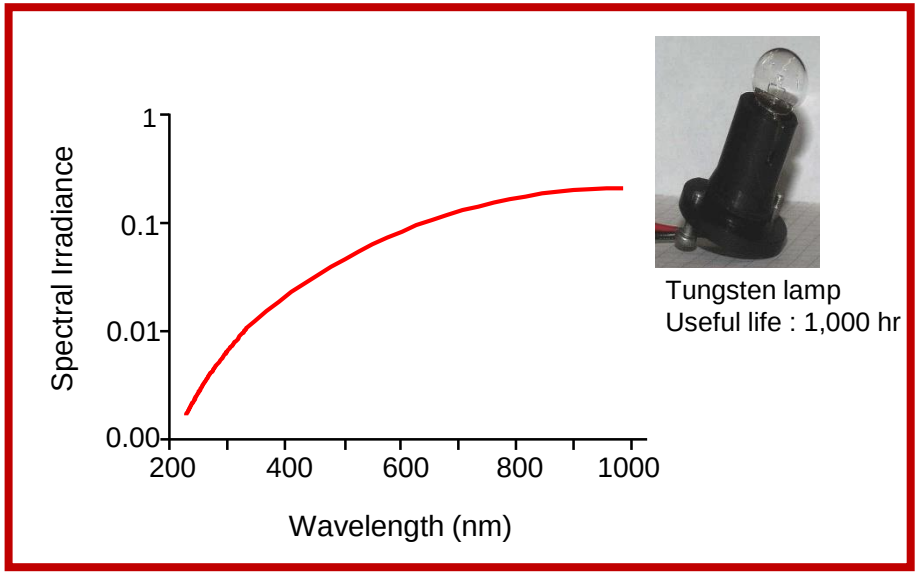
Lock Down mechanism

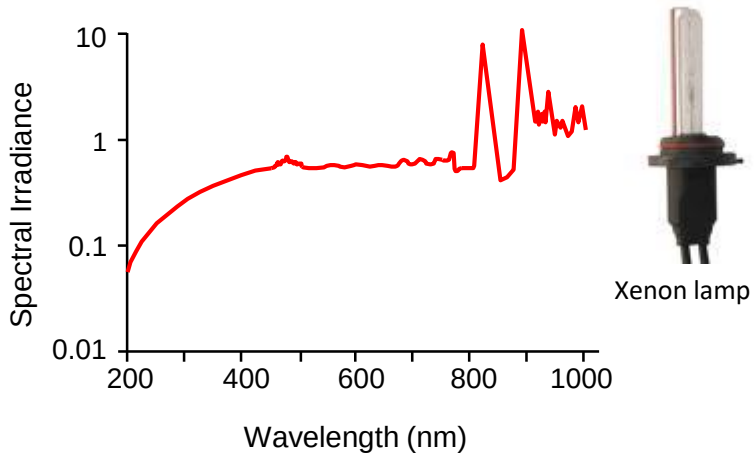
PMT & PbS detectors

Typical light sources

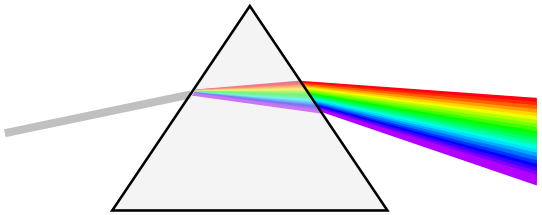








Dispersion devices



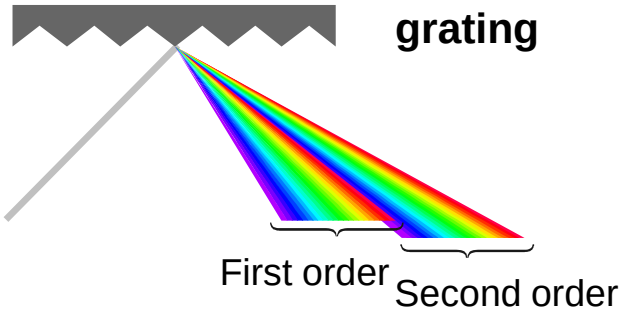
Dispersive device = **prism**

Advantages

- simple to make
- low cost

Disadvantages

- angular dispersion is non-linear
- angular dispersion is temperature sensitive
- must use additional optical components for focusing



Advantages

- linear angular dispersion
- not temperature sensitive
- may be made on curved surface which simultaneously function as focusing optics

Disadvantages

- multiple orders mean high “stray” light at longer wavelengths
- must use additional filters
- higher cost

Detectors

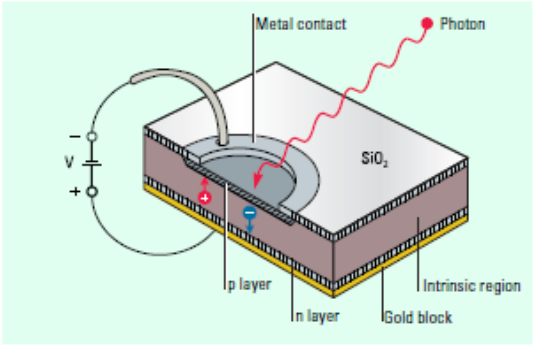
- **Photomultiplier tube**

- High sensitivity at low light levels
- Good signal/noise
- Shock sensitive

- **PbS : lead sulfide photocell**

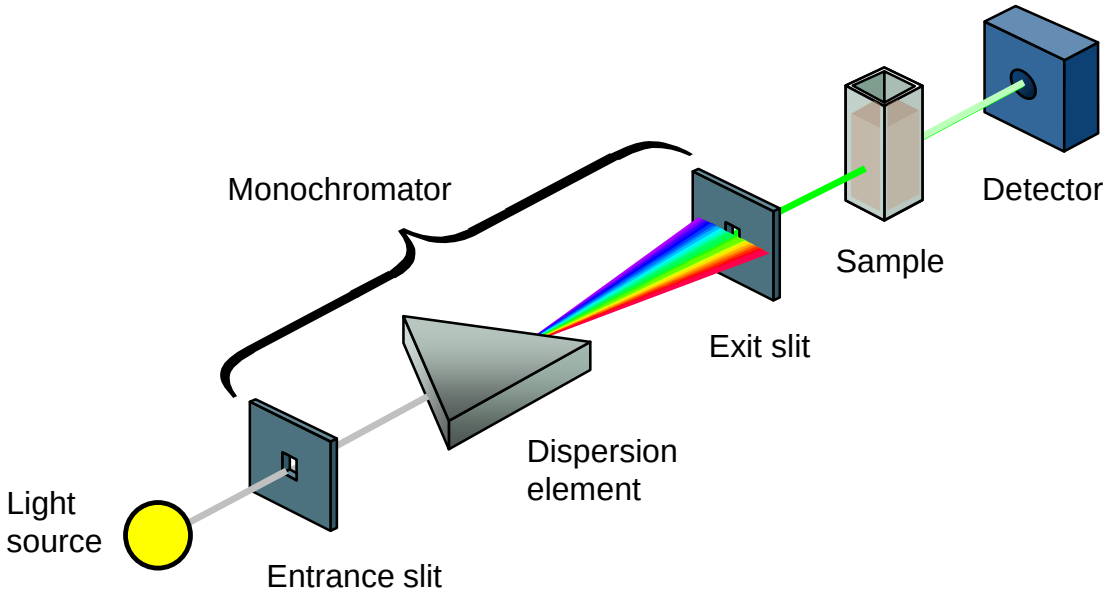
- Electrothermally cooled
- Stablized near 0˚ Celsius

- **Photodiode detector**



- Silicon based detector
- A diode array consists of a series of photodiode detectors to increase sensitivity.
- Detection limit : 170 – 1,100 nm

Single beam spectrometer



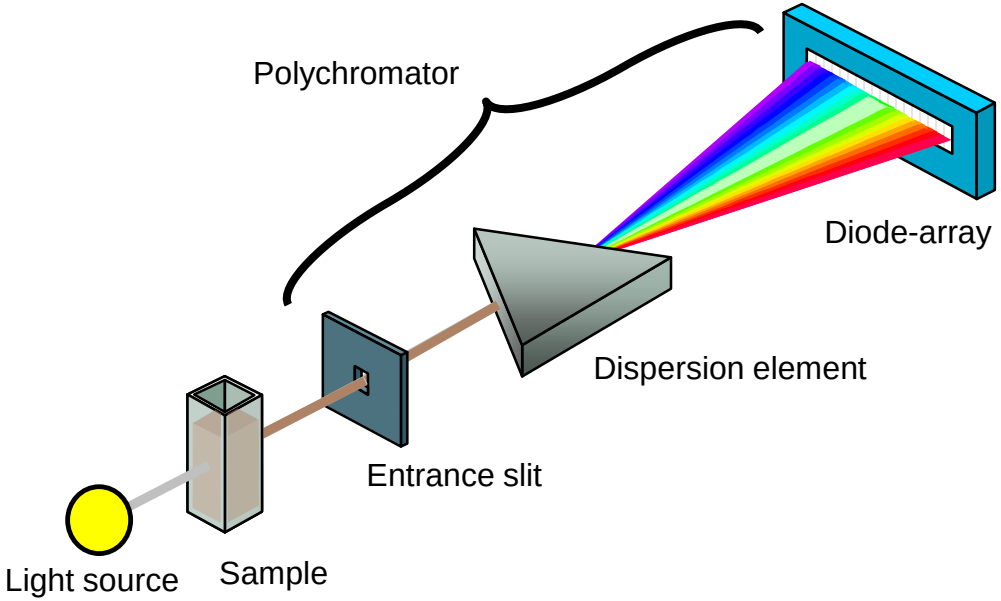
Advantages

- Simple optical system and low cost

Disadvantages

- A spectrum is acquired very quickly.
- The sample and reference don't measure at the same time.
  → a drift of lamp and time difference

Photodiode array spectrometer



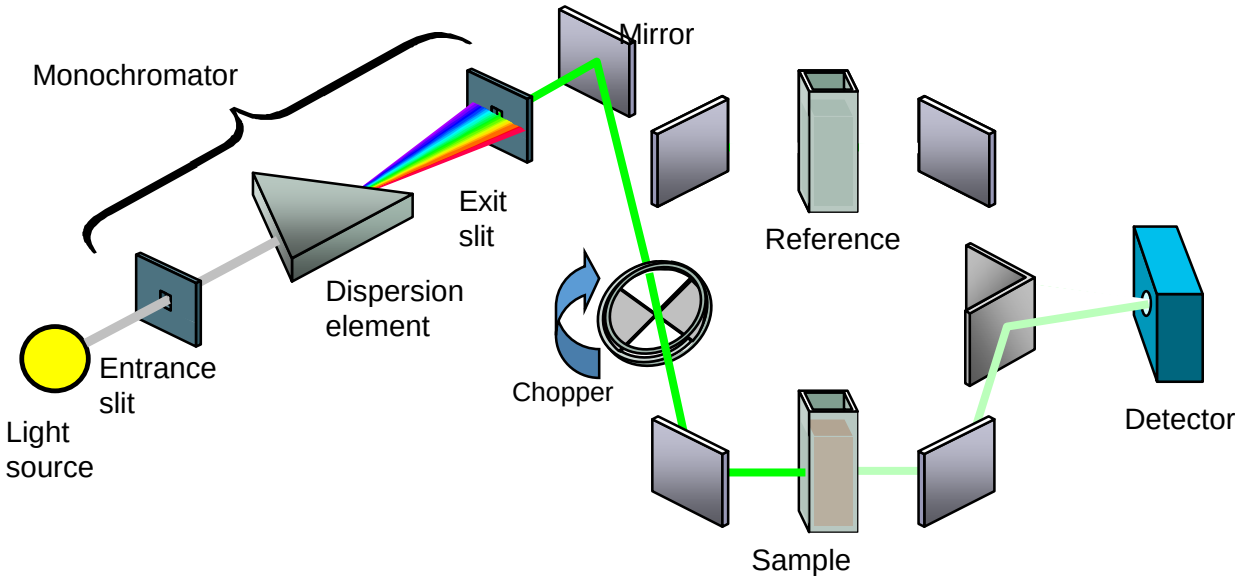
Advantages

- No moving part → excellent wavelength reproducibility
- Measure all wavelength at a time

Disadvantages

- A drift of lamp and time difference
- Photochemical reactions due to reach all wavelength to the sample

Double beam spectrometer



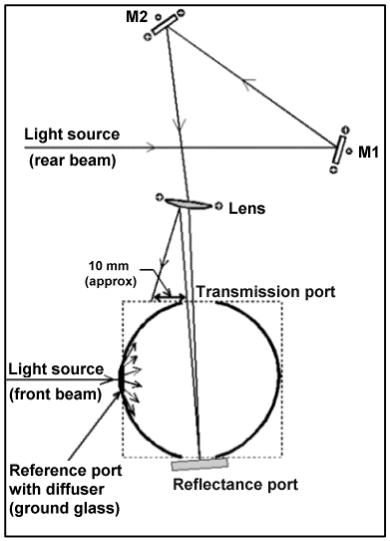
Advantages

- Low changes in lamp intensity between measurements on the blank and sample.
- Higher stability, sensitivity, resolution and accuracy

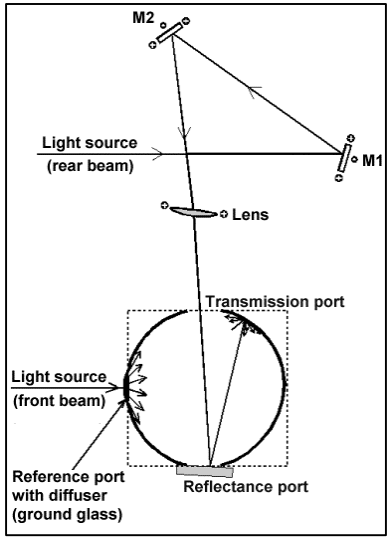
Disadvantages

- Slow scan speed
- Complex optical design and expensive cost

Diffuse Reflectance Accessory (DRA)



"D" – diffuse



"S" - total

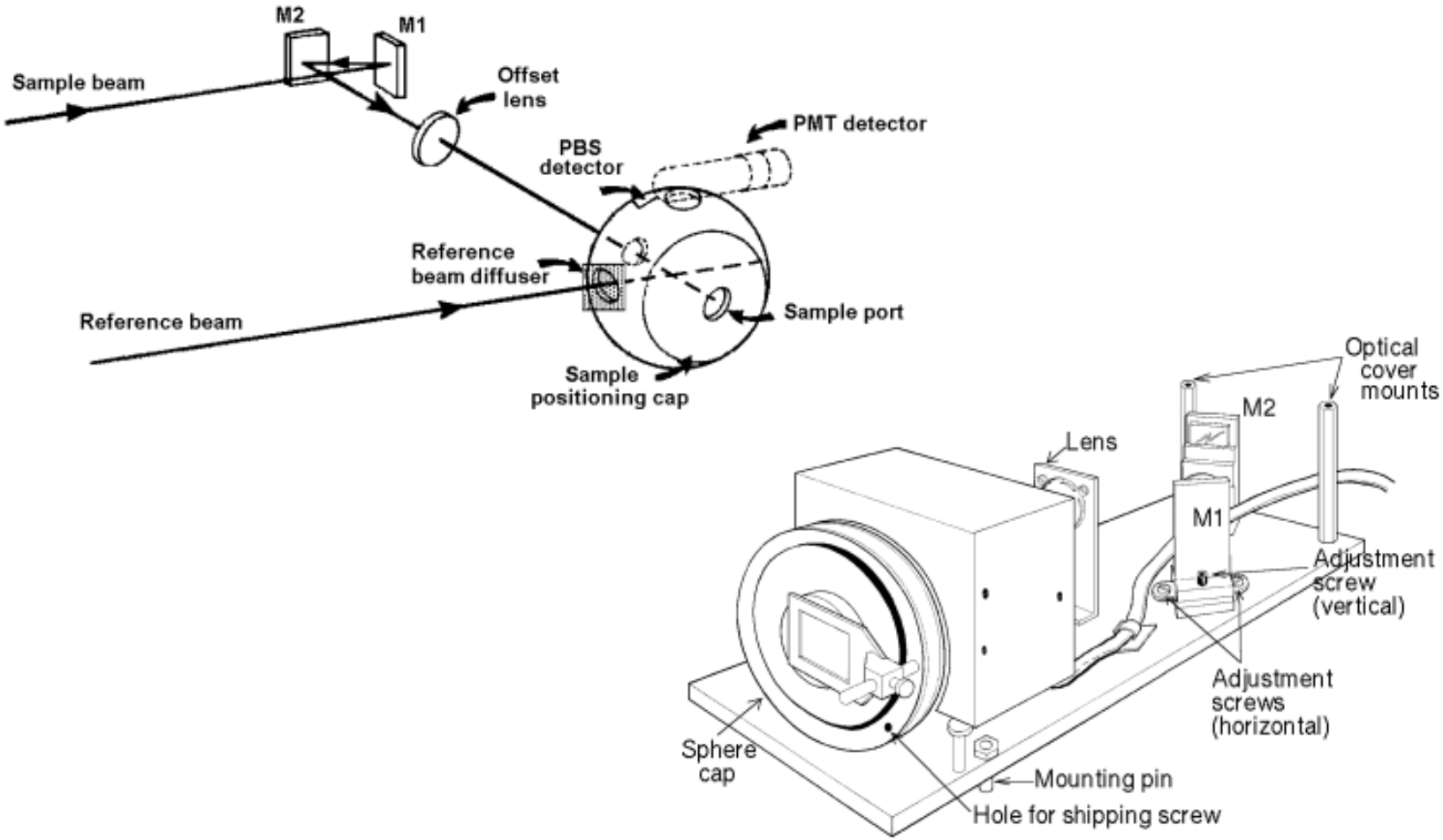
Specifications

- Model : DRA 2500
- Wavelength range : 250 ~ 2,500 nm
- Sphere diameter : 110 mm
- Internal coating : Polytetrafluoroethylene (PTFE)
- Coating thickness : 4 mm
- Sample plane normal deviation
  - diffuse reflectance : 0˚
  - total reflectance : 3˚ 20 min
- Port size : 16 mm
- Minimum sample size : approx. 8 mm (w) X 12 mm (h)
- Maximum sample size : 100 mm (w) X 200 mm (h)

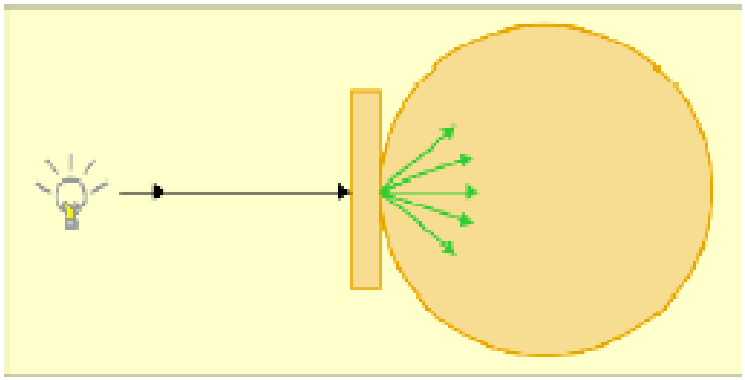
Applications

- Characterization of a painted surface
- Transmission measurement of turbid materials
- Surface analysis of a powder

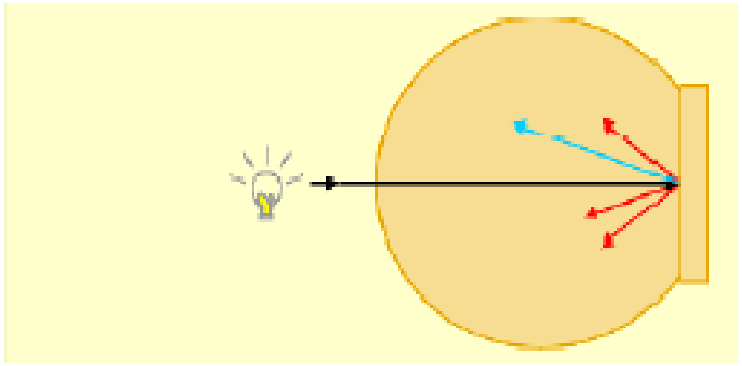
Diffuse Reflectance Accessory



DRA – measurement modes



Diffuse Transmission

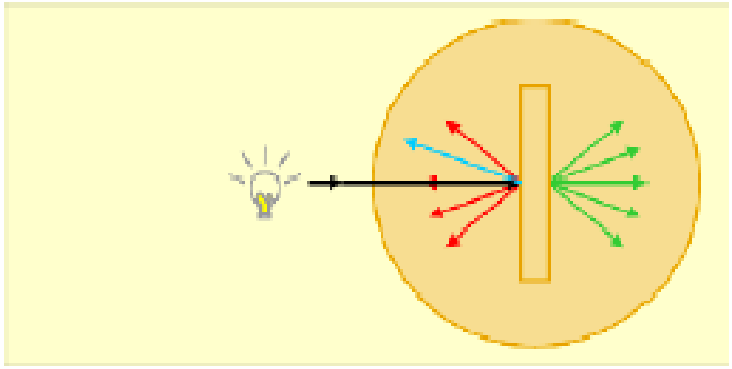


Diffuse Reflectance

Specular Reflectance

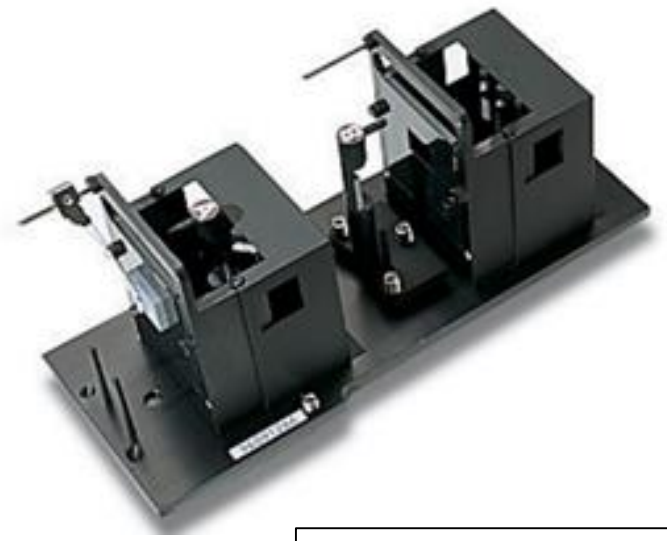
Diffuse Reflectance

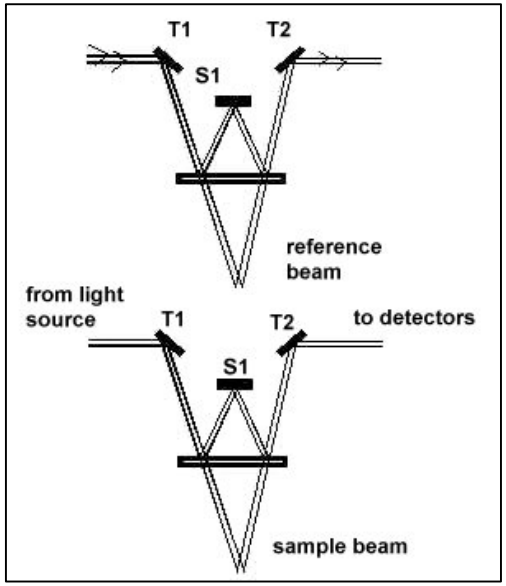
Diffuse Transmission



Transflectance
Diffuse T and R

VW Specular Reflectance Accessory (VWSRA)





The optical design

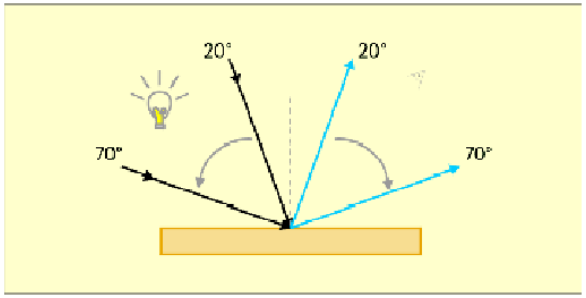
Specifications

- Model : VW SRA
- Wavelength range : 175 ~ 3,300 nm
- Incident angle : 7˚
- Minimum sample
  - two reflections : 25 mm X 13 mm
  - single reflection : 8 mm X 13 mm
- Maximum sample thickness : 35 mm

Applications

- High or low specular reflectance materials
- Determine optical constants of materials
- Measure film/coating thickness
- Refractive index determinations
- Obtain absolute reflectance measurements

Variable Angle Specular Reflectance Accessory (VASRA)



The available angle

Specifications

- Model : VASRA
- Wavelength range : 175 ~ 3,300 nm
- Measurement angles : 20˚ - 70˚
- Maximum sample size

Angle	Length	Height	Thickness
20	150	140	65 mm
45	235	140	53 mm
70	243	140	35 mm

Applications

- Reflectance of materials at various angles
- Determine optical constants of materials
- Measure film/coating thickness
- Refractive index determinations

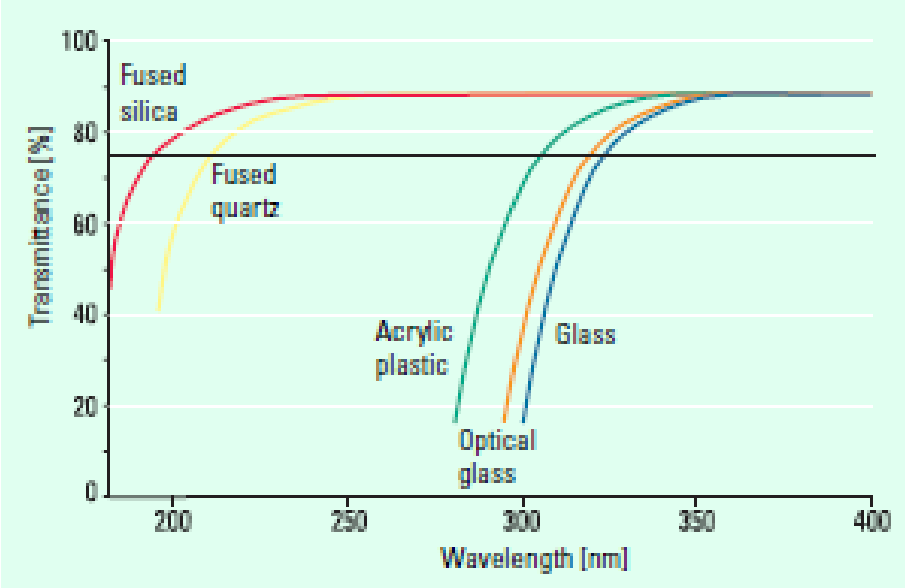
4. Pre-treatment

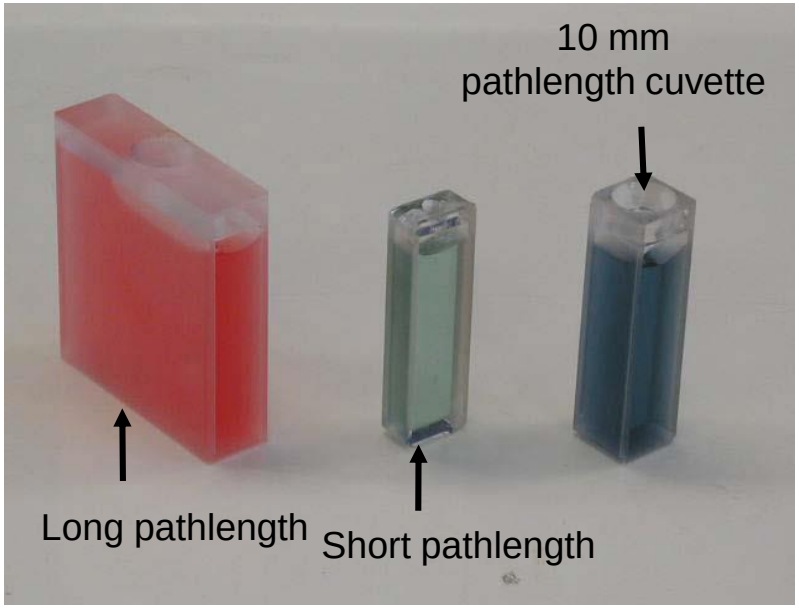
-시료 준비

-전처리

Liquid samples - sample compartment

- A liquid sample is usually contained in a cell called a cuvette for visible and UV spectroscopy**.**
- Glass and plastic is suitable for visible but not for UV spectroscopy (below 320 nm) because it absorbs UV radiation. Quartz can be used in UV as well as in visible spectroscopy.





Common solvents and cutoffs

- Solvents must be transparent in the region to be observed.
- Since spectra are only obtained up to 200 nm, solvent typically only need to lack conjugated π systems or carbonyls.

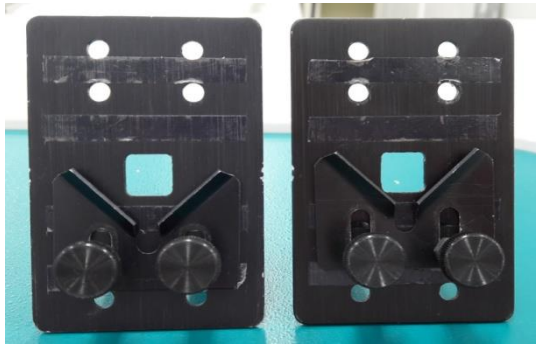
Properties of some common solvents

Solvent	Polarity	Cut-off Wavelength (nm)	Hazard
Distilled water	78.5	<195	none
Hexane	1.9	199	flammable
Ethanol (absolute)	24.3	207	flammable
Methanol	32.6	210	flammable
Cyclohexane	2.0	211	flammable
Chloroform	4.8	246	Flammable/toxic
Dimethylsulfoxide	none	270	Health hazard
Acetone	20.7	331	flammable

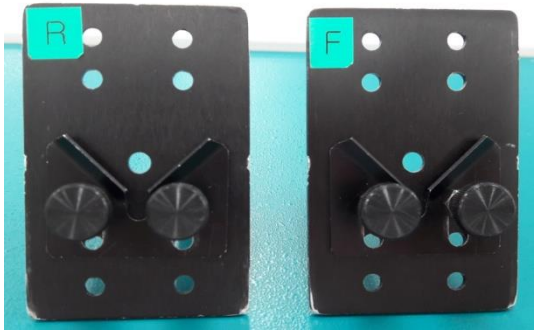
Solid samples

- Prepare two references, it is set double beam spectrometer.
- Select a proper sample holder among 5 mm, 10 mm, and standard aperture.
- If the sample is very weak absorptivity S/N can be improved by increasing the slit width and integration time.

Std. aperture



10 mm aperture



5 mm aperture

5. UV-Vis-NIR Operation

-작동방법 manual

-구동 software

-기본 setting

-결과 분석 및 처리 software

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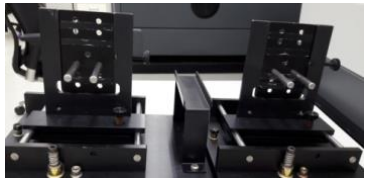
❖ Solid & Liquid acc.

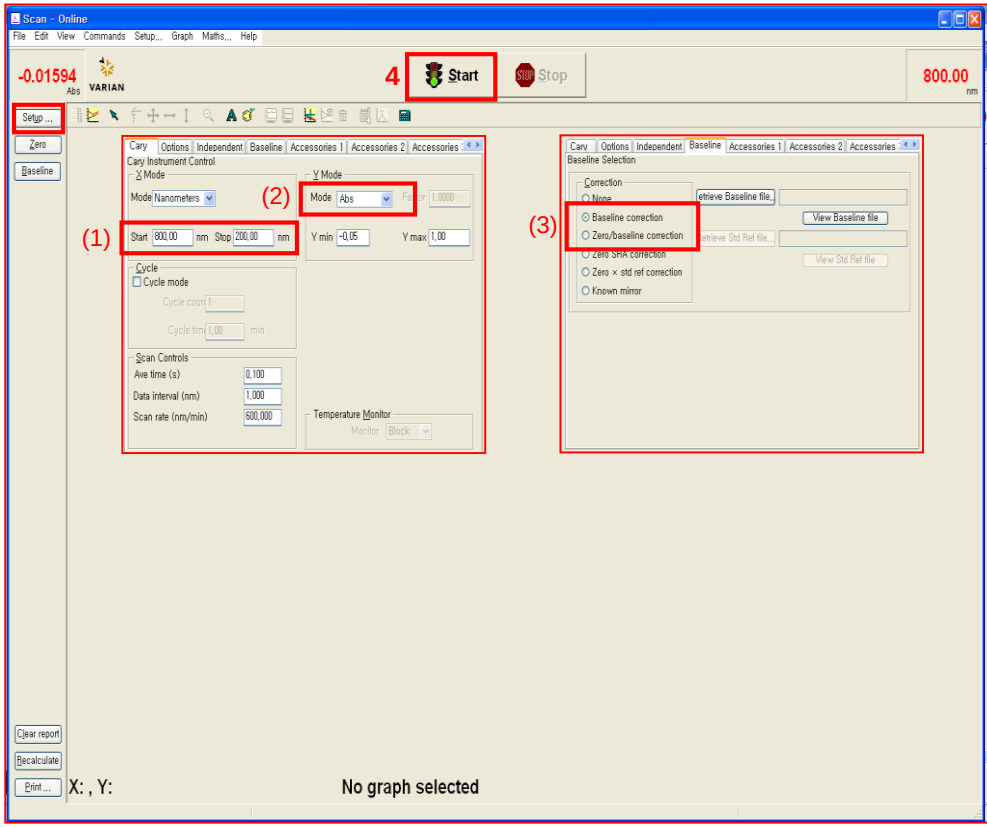
1. Change a Solid or Liquid acc.

Solid acc.



Liquid acc.

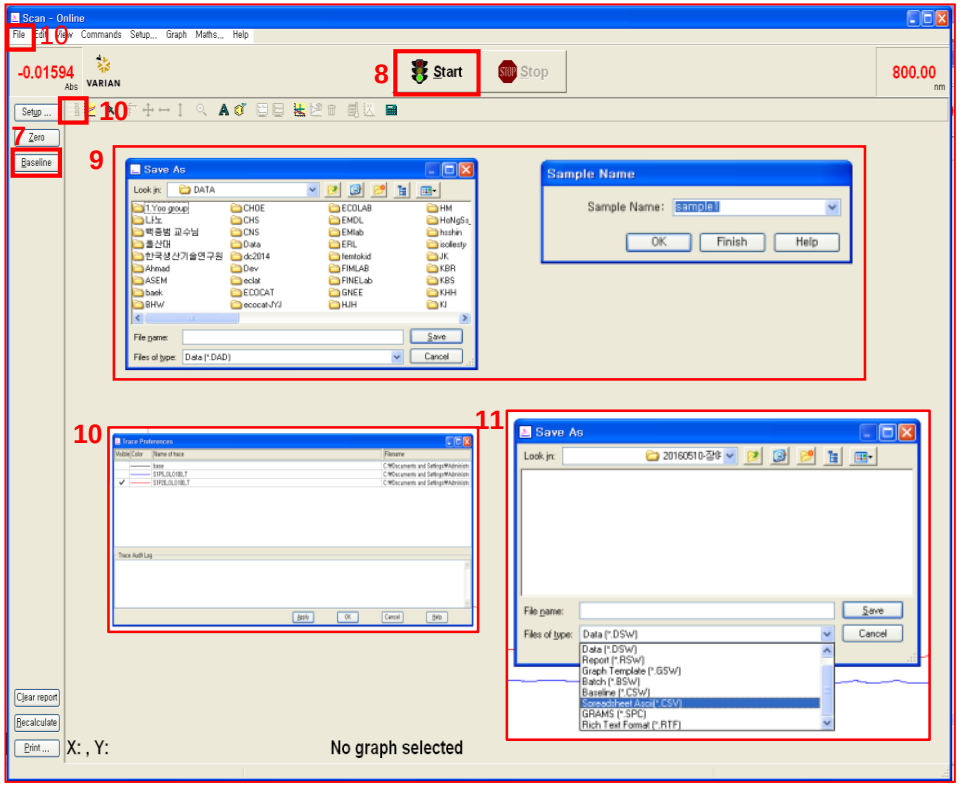
2. Power on → warm up (min.10 min)
3. Open a Scan program
4. Check a activation of Start icon
5. Setup : measurement conditions
   (1) wavelength range : 3,300 ~ 200 nm
   (2) Mode : Abs, %T
   (3) Baseline : Baseline correction
   Zero/baseline correction : low permeability samples



Manual

6. Put two blank samples into reference and sample holder
7. Click baseline → measure 100% T baseline & 0% T baseline
8. Load a measurement sample in the sample holder → Click “Start” icon
9. Make a new file and input a sample name → OK (start to scan)
10. Trace preferences : select spectrum
11. Convert to txt files

    File–save data as–spreadsheet ascii (.csv)
12. Close a program → power off
13. Upload the data on NAS server



❖ DRA (Diffuse Reflection Accessory)

“S” mode : total reflection

“D” mode : diffuse reflection

Check to lock a DRA into the main body.

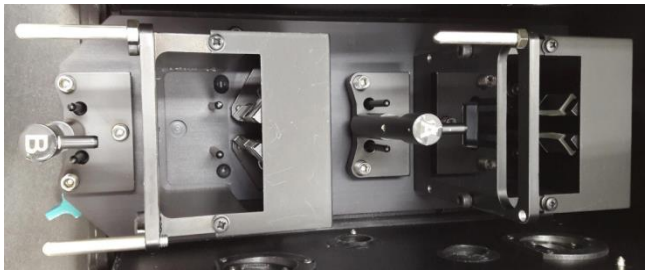
❖ DRA (Diffuse Reflection Accessory)

5. Setup : measurement conditions

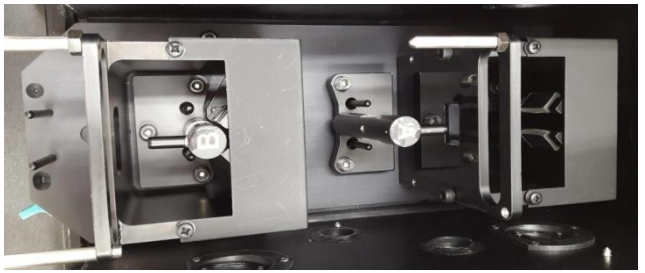
DRA Measurement conditions

Cary tab		**Options tab**	
Mode	%R	SBW (nm)	2.00
Ave time (s)	**> 0.200**	Beam mode	Double
Data interval (nm)	< 1.000	Slit height	**Reduced**
Scan rate (nm/min)	< 300.00	Reference	PTFE (polytetrafluoroethylene)
Baseline tab		Zero/baseline correction	

❖ VW SRA (VW Specular Reflection Accessory)



“VV” position : 100% R



“VW” position : 0% R

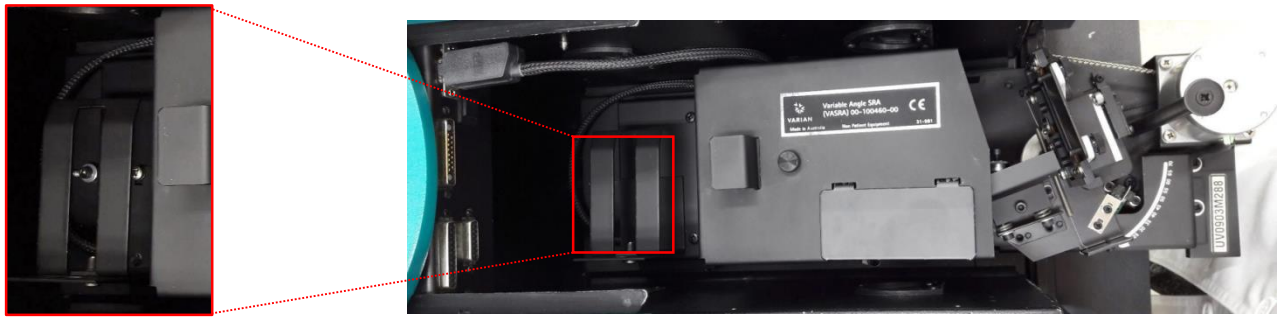
5. Setup : measurement conditions

SRA Measurement conditions

Cary tab		Options tab	
Mode	%R	SBW (nm)	1.00
Ave time (s)	> 0.067	Beam mode	Double
Data interval (nm)	< 0.500	Slit height	Reduced
Scan rate (nm/min)	< 300.00	Reference	Al mirror
Baseline tab		Zero SRA correction Known mirror	

❖ VASRA (Variable Angle Specular Reflectance Accessory)

- Fix it to the main body



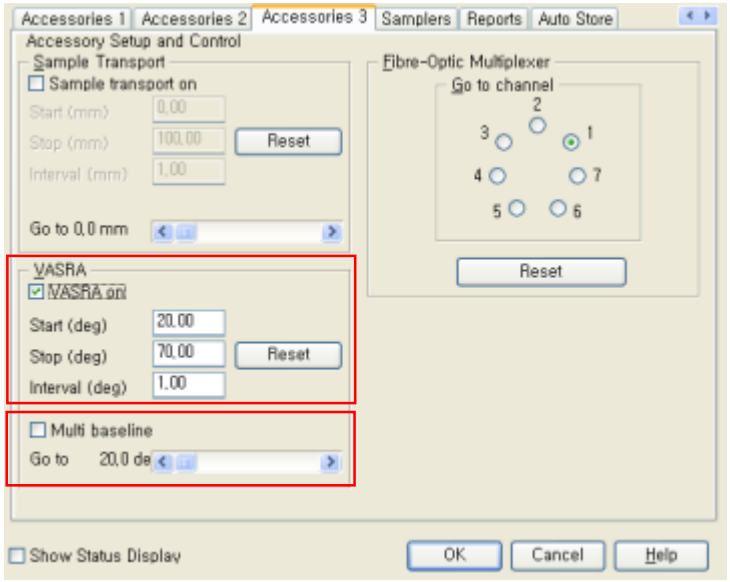
5. Setup : measurement conditions

SRA Measurement conditions

Cary tab		Options tab	
Mode	%R	SBW (nm)	2.00
Ave time (s)	> 0.200	Beam mode	Double
Data interval (nm)	< 1.000	Slit height	Reduced
Scan rate (nm/min)	< 300.00	Reference	Al mirror
Baseline tab		Zero/baseline correction	

❖ VASRA acc.

6. Accessories 3 – check a VASRA on
7. Select a Start (deg), Stop (deg), Interval (deg)
8. Check a Multi baseline (maximum points : 11)



6. Technical Knowhow

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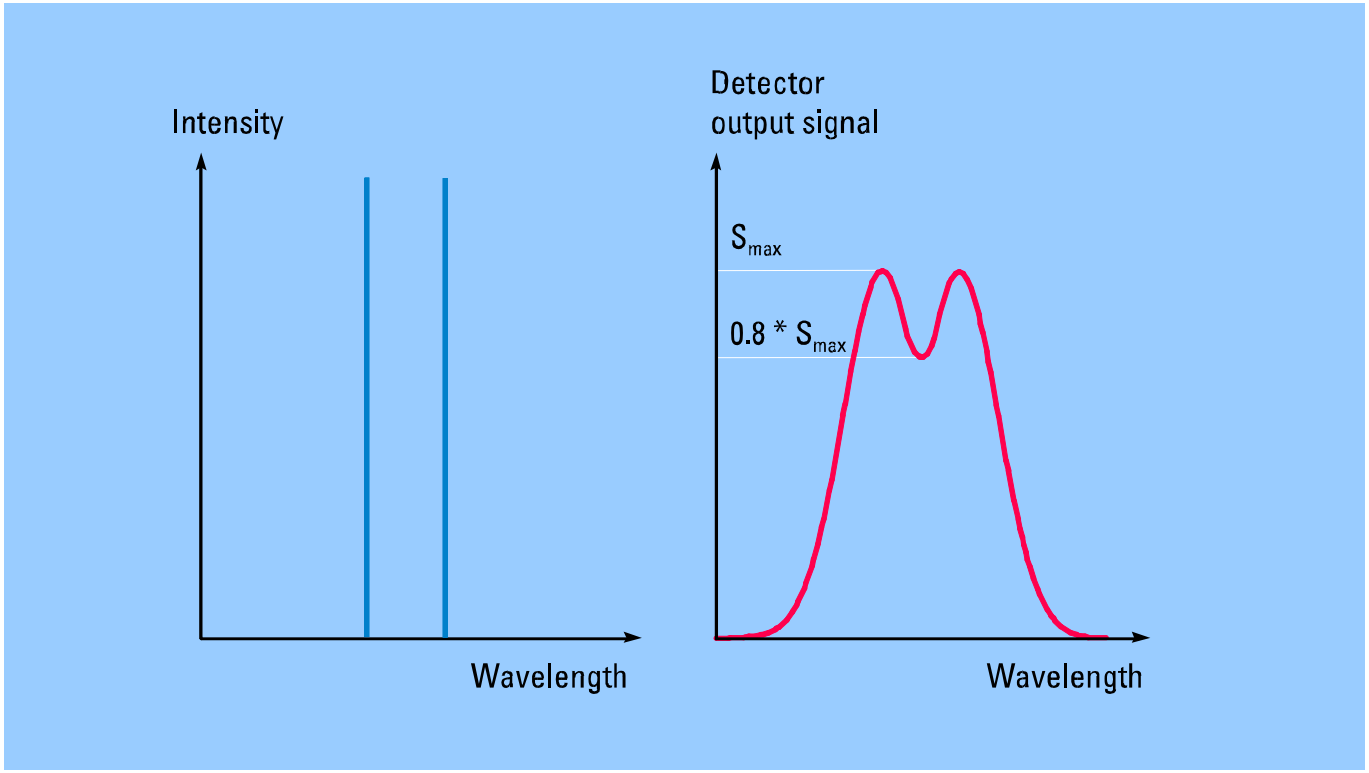
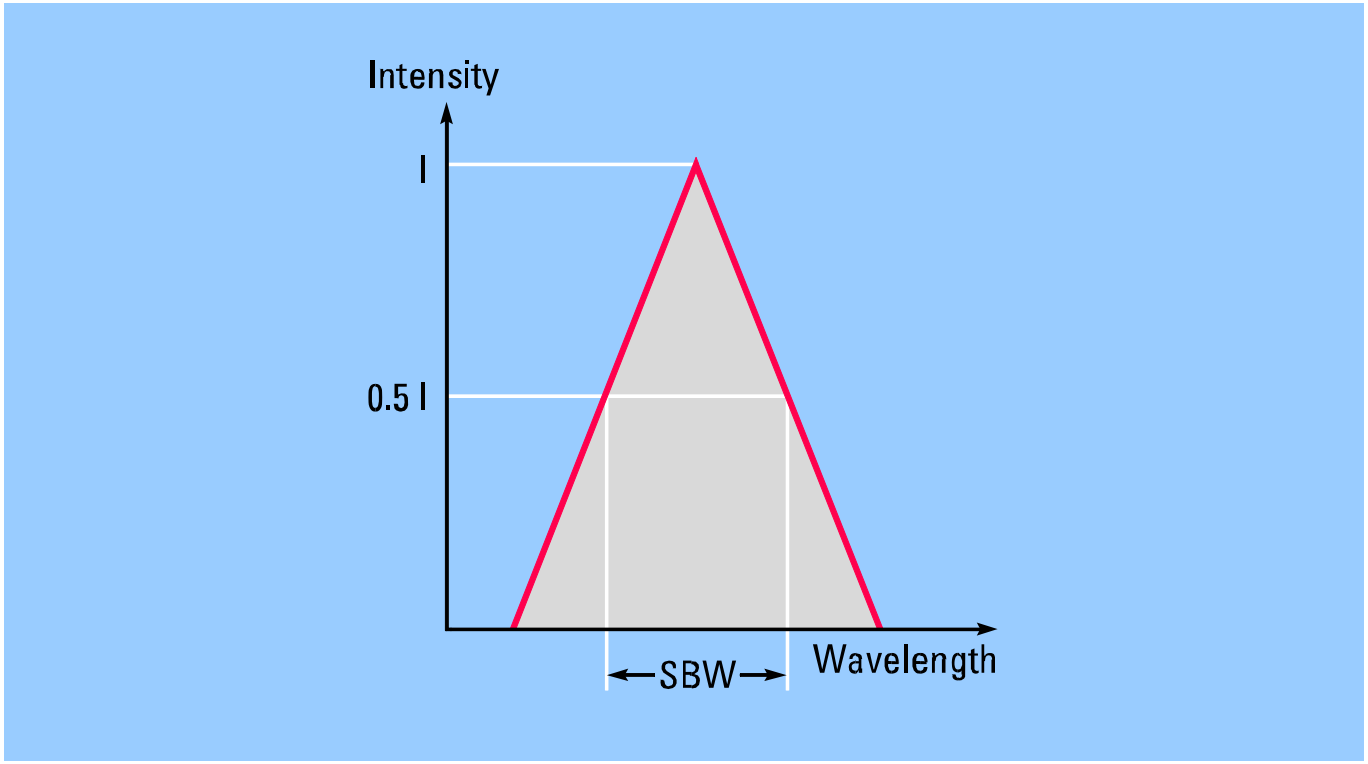
Definition of resolution



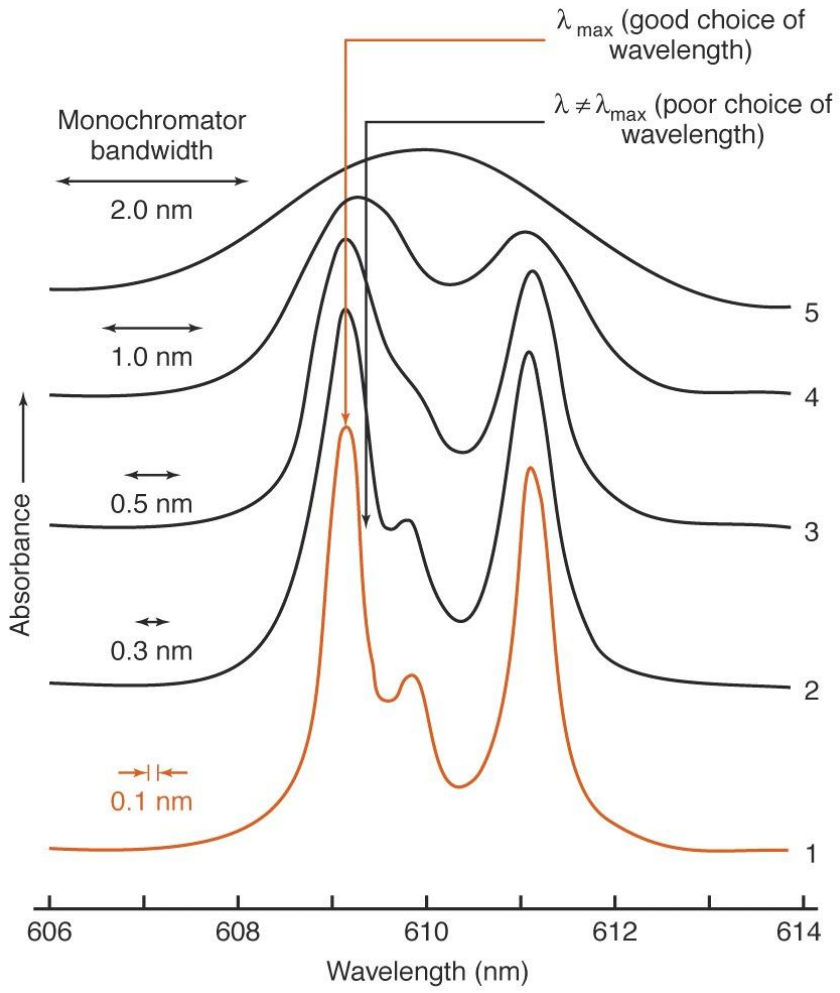
Spectral resolution is a measure of the ability of an instrument to differentiate between two adjacent wavelengths

Instrumental spectral bandwidth



The SBW is defined as the width, at half the maximum intensity, of the band of light leaving the monochromator.

Bandwidth choice



- The size of the monochromator exit slit determines the width of radiation (bandwidth) emitted from the monochromator.

- Wider slit width : higher sensitivity
  Narrow slit width : better resolution

7. Cautions

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Cautions

- ✓ Check a installation of solid or liquid sampler holder before using it.

Good

Wrong

Wrong

- ✓ Do not open a door when it is initializing.
- ✓ Turn off the spectrometer and remove cell holders from compartment.

  Close the sample compartment, turn the spectrometer in and allow it to initialize.

  Position the DRA accessory so that the two rear lock-down feet are situated.
- ✓ Be careful PTFE reference doesn’t scratch.
- ✓ Cells should be handled carefully to prevent scratching.
- ✓ Avoid touching the optical surfaces, mirrors and lenses with the fingers.

8. FAQ

-자주 하는 질문

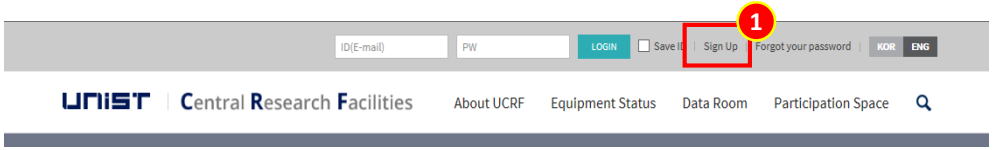
-장비 이용료

Reservation control information

Reservation time unit	Daily maximum reservation time	Cancelable timing	Fee	
30 min.	4.0 hr	2.0 hr	Client	10,000/ea
			Self-user	10,000/hr
			Acc. used	10,000/ea

Create Account

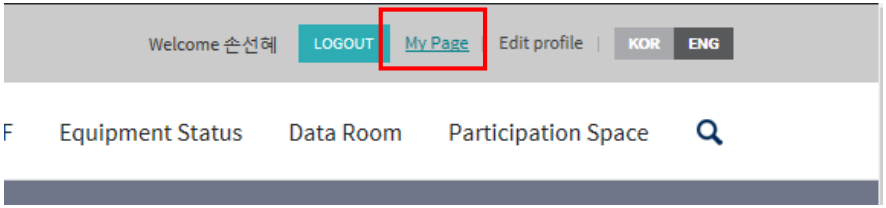
www.ucrf.unist.ac.kr

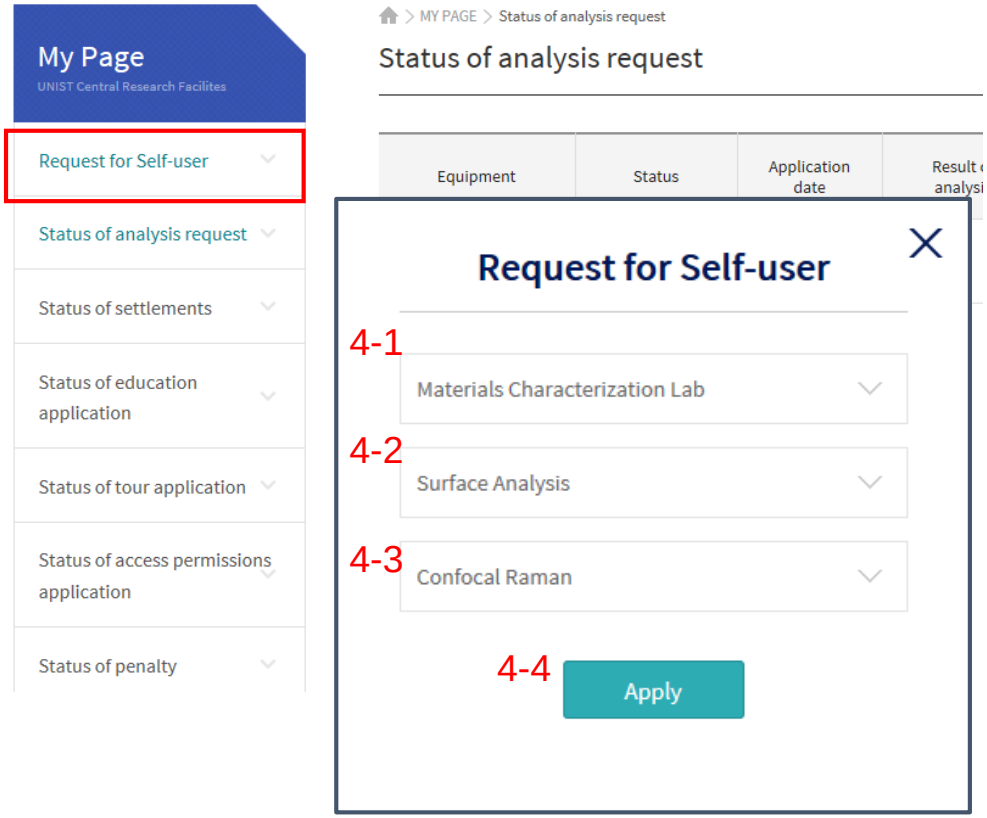


1. Click [Sign up].
2. Click [UNIST Member].
3. Input [Portal id/pw]_Click [Confirm].
   Please check your information.
4. Input professor name in [Principal investigation]
   _Click [Professor search]_Click professor name.
5. Click [Create Account].

Request for Self-user

www.ucrf.unist.ac.kr



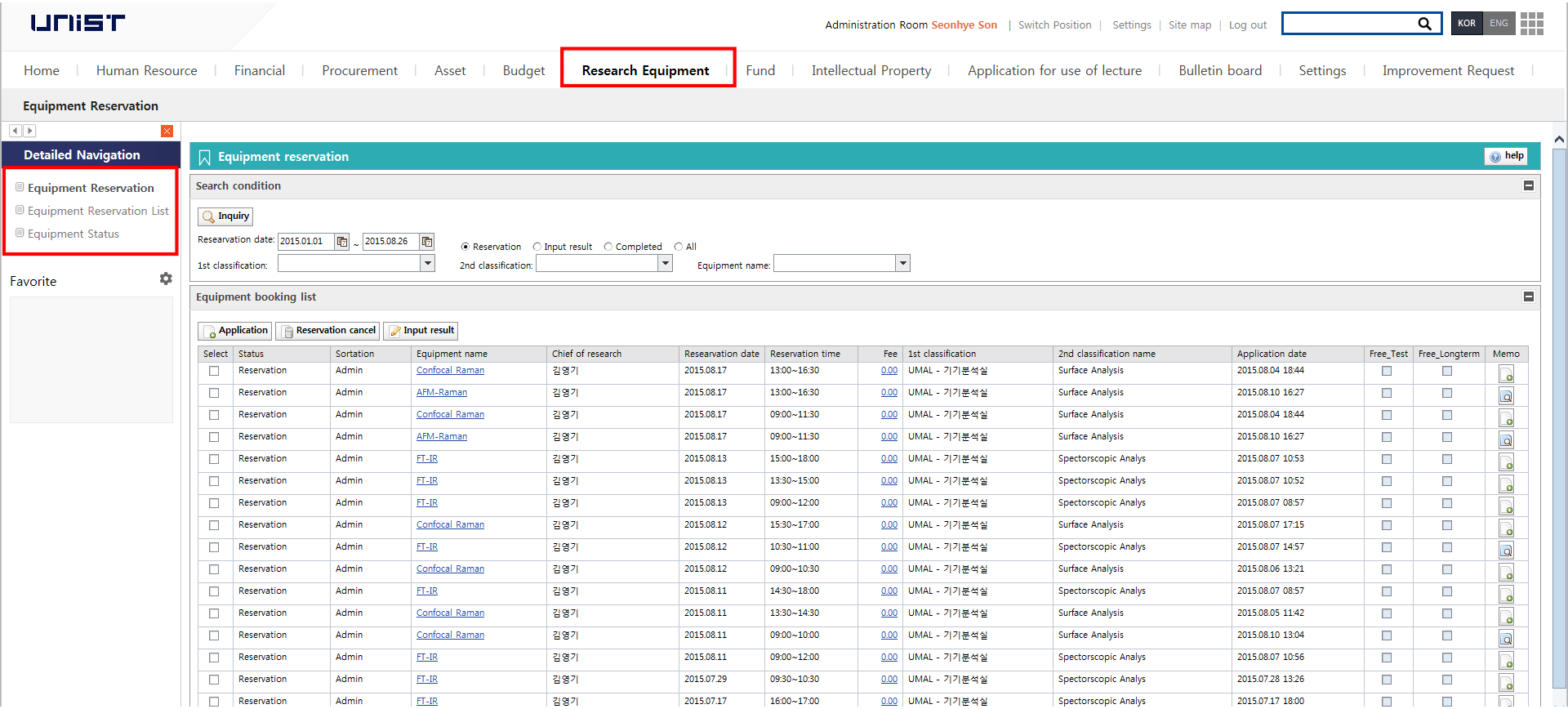


After pass the test,

1. Login UCRF website.
2. Click [My Page].
3. Click [Request for Self user].
4. Select the equipment.
    1) Select [Materials Characterization Lab].
    2) Select [Surface Analysis].
    3) Select [Confocal Raman].
    4) Click [Apply].

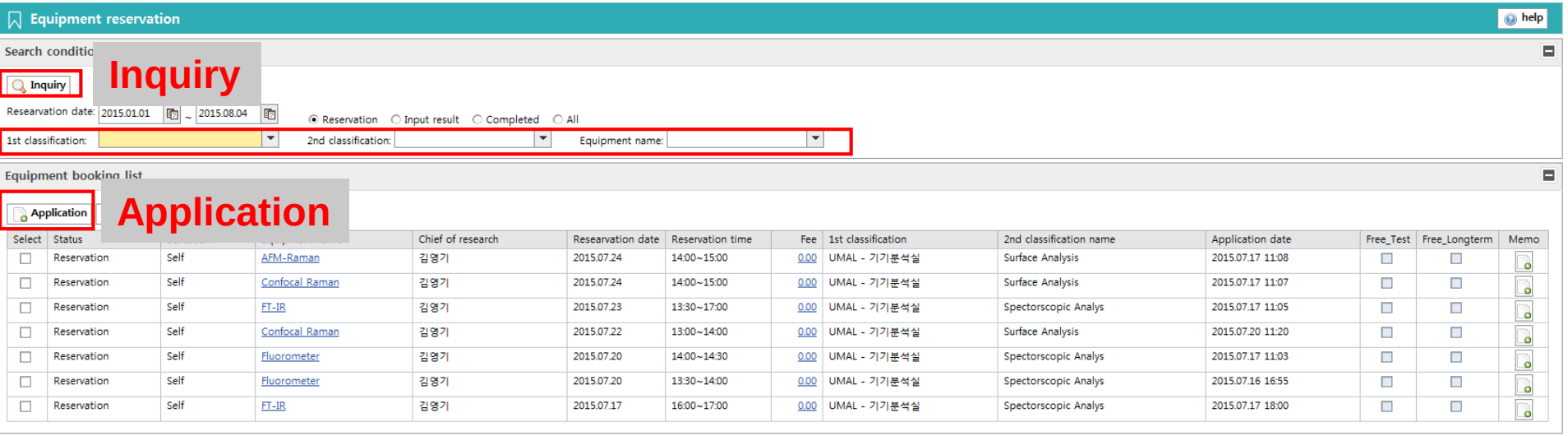
Reservation

portal.unist.ac.kr – Research Equipment– Equipment reservation/input result



Select	Status	Sortation	Equipment name	Chief of research	Reseravation date	Reservation time	Fee	1st classification	2nd classification name	Application date	Free_Test	Free_Longterm	Memo
☐	Reservation	Admin	Confocal Raman	김영기	2015.08.17	13:00~16:30	0.00	UMAL - 기기분석실	Surface Analysis	2015.08.04 18:44	☐	☐	
☐	Reservation	Admin	AFM-Raman	김영기	2015.08.17	13:00~16:30	0.00	UMAL - 기기분석실	Surface Analysis	2015.08.10 16:27	☐	☐	
☐	Reservation	Admin	Confocal Raman	김영기	2015.08.17	09:00~11:30	0.00	UMAL - 기기분석실	Surface Analysis	2015.08.04 18:44	☐	☐	
☐	Reservation	Admin	AFM-Raman	김영기	2015.08.17	09:00~11:30	0.00	UMAL - 기기분석실	Surface Analysis	2015.08.10 16:27	☐	☐	
☐	Reservation	Admin	FT-IR	김영기	2015.08.13	15:00~18:00	0.00	UMAL - 기기분석실	Spectorscopic Analys	2015.08.07 10:53	☐	☐	
☐	Reservation	Admin	FT-IR	김영기	2015.08.13	13:30~15:00	0.00	UMAL - 기기분석실	Spectorscopic Analys	2015.08.07 10:52	☐	☐	
☐	Reservation	Admin	FT-IR	김영기	2015.08.13	09:00~12:00	0.00	UMAL - 기기분석실	Spectorscopic Analys	2015.08.07 08:57	☐	☐	
☐	Reservation	Admin	Confocal Raman	김영기	2015.08.12	15:30~17:00	0.00	UMAL - 기기분석실	Surface Analysis	2015.08.07 17:15	☐	☐	
☐	Reservation	Admin	FT-IR	김영기	2015.08.12	10:30~11:00	0.00	UMAL - 기기분석실	Spectorscopic Analys	2015.08.07 14:57	☐	☐	
☐	Reservation	Admin	Confocal Raman	김영기	2015.08.12	09:00~10:30	0.00	UMAL - 기기분석실	Surface Analysis	2015.08.06 13:21	☐	☐	
☐	Reservation	Admin	FT-IR	김영기	2015.08.11	14:30~18:00	0.00	UMAL - 기기분석실	Spectorscopic Analys	2015.08.07 08:57	☐	☐	
☐	Reservation	Admin	Confocal Raman	김영기	2015.08.11	13:30~14:30	0.00	UMAL - 기기분석실	Surface Analysis	2015.08.05 11:42	☐	☐	
☐	Reservation	Admin	Confocal Raman	김영기	2015.08.11	09:00~10:00	0.00	UMAL - 기기분석실	Surface Analysis	2015.08.10 13:04	☐	☐	
☐	Reservation	Admin	FT-IR	김영기	2015.08.11	09:00~12:00	0.00	UMAL - 기기분석실	Spectorscopic Analys	2015.08.07 10:56	☐	☐	
☐	Reservation	Admin	FT-IR	김영기	2015.07.29	09:30~10:30	0.00	UMAL - 기기분석실	Spectorscopic Analys	2015.07.28 13:26	☐	☐	
☐	Reservation	Admin	FT-IR	김영기	2015.07.17	16:00~17:00	0.00	UMAL - 기기분석실	Spectorscopic Analys	2015.07.17 18:00	☐	☐	

Reservation

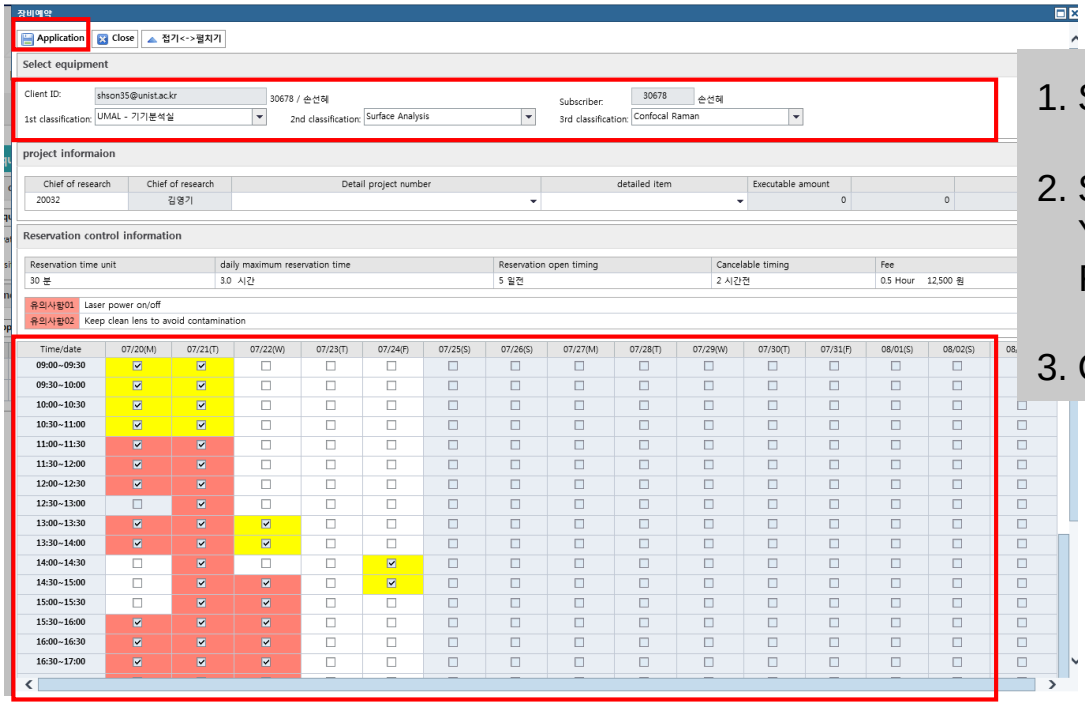


Select	Status			Chief of research	Reservation date	Reservation time	Fee	1st classification	2nd classification name	Application date	Free_Test	Free_Longterm	Memo
☐	Reservation	Self	AFM-Raman	김영기	2015.07.24	14:00~15:00	0.00	UMAL - 기기분석실	Surface Analysis	2015.07.17 11:08	☐	☐	
☐	Reservation	Self	Confocal Raman	김영기	2015.07.24	14:00~15:00	0.00	UMAL - 기기분석실	Surface Analysis	2015.07.17 11:07	☐	☐	
☐	Reservation	Self	FT-IR	김영기	2015.07.23	13:30~17:00	0.00	UMAL - 기기분석실	Spectorscopic Analys	2015.07.17 11:05	☐	☐	
☐	Reservation	Self	Confocal Raman	김영기	2015.07.22	13:00~14:00	0.00	UMAL - 기기분석실	Surface Analysis	2015.07.20 11:20	☐	☐	
☐	Reservation	Self	Fluorometer	김영기	2015.07.20	14:00~14:30	0.00	UMAL - 기기분석실	Spectorscopic Analys	2015.07.17 11:03	☐	☐	
☐	Reservation	Self	Fluorometer	김영기	2015.07.20	13:30~14:00	0.00	UMAL - 기기분석실	Spectorscopic Analys	2015.07.16 16:55	☐	☐	
☐	Reservation	Self	FT-IR	김영기	2015.07.17	16:00~17:00	0.00	UMAL - 기기분석실	Spectorscopic Analys	2015.07.17 18:00	☐	☐	

3

1

2

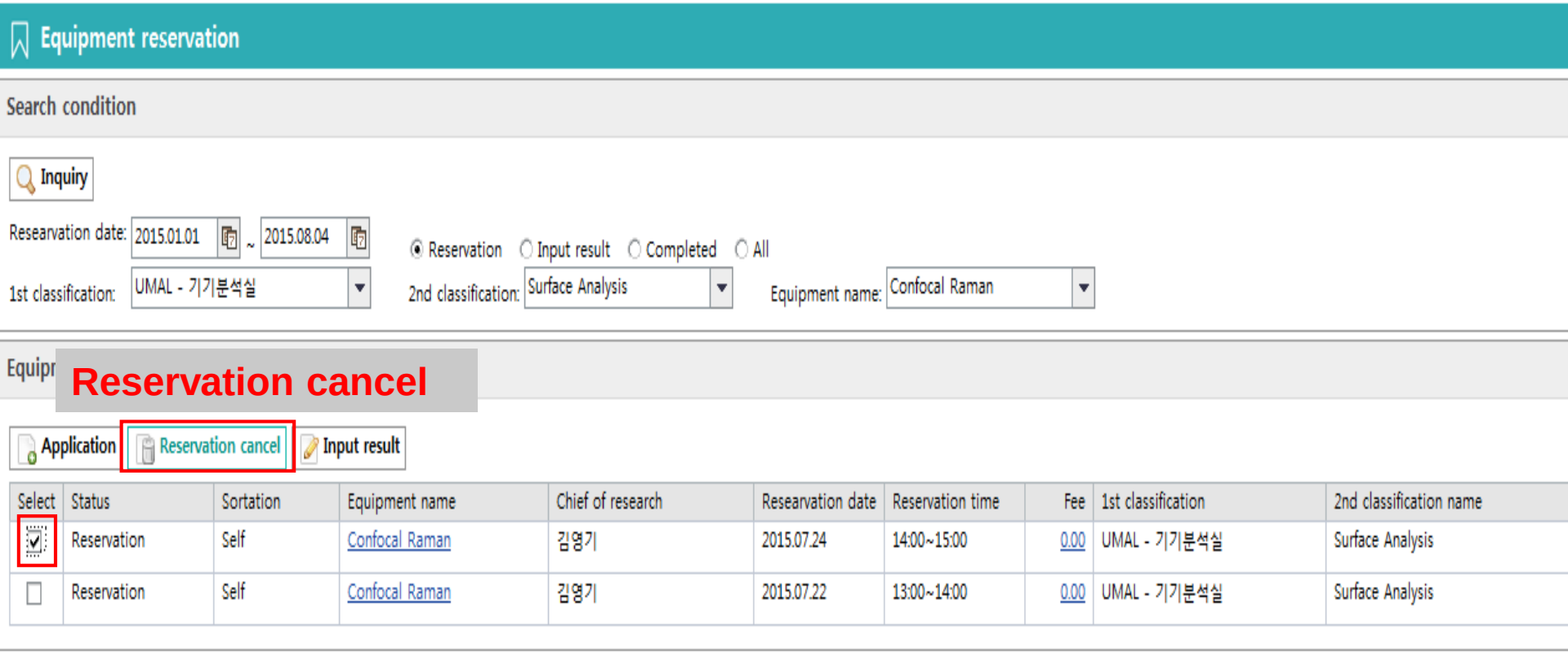


1. Select the classification and equipment

2. Select the time you want on white box.
   Yellow box : my reservation
   Red box : others reservation

3. Click [Application].

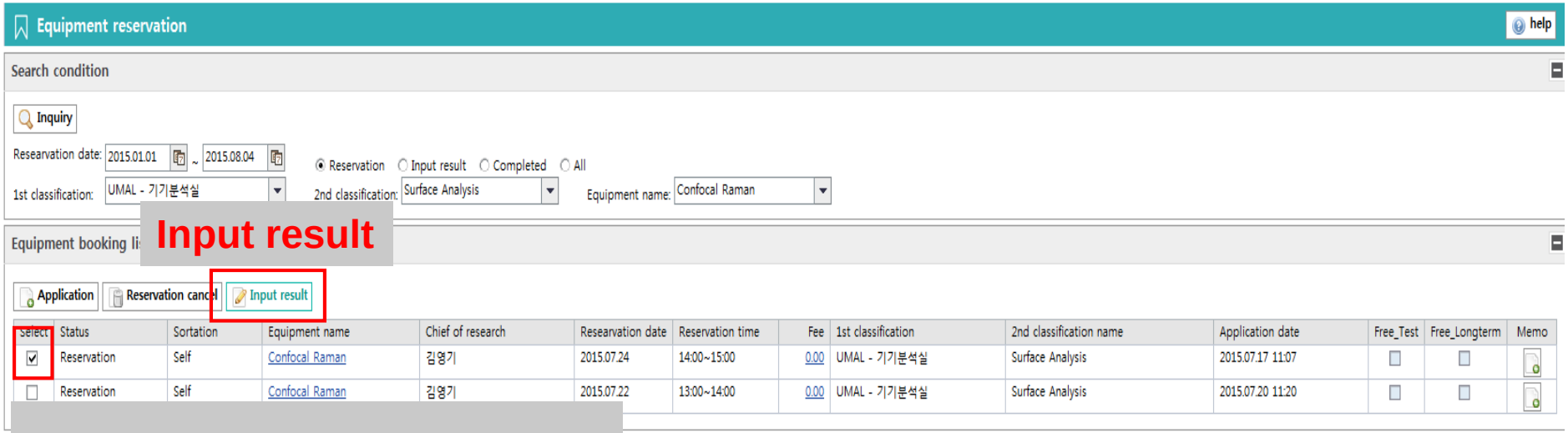
Reservation cancel



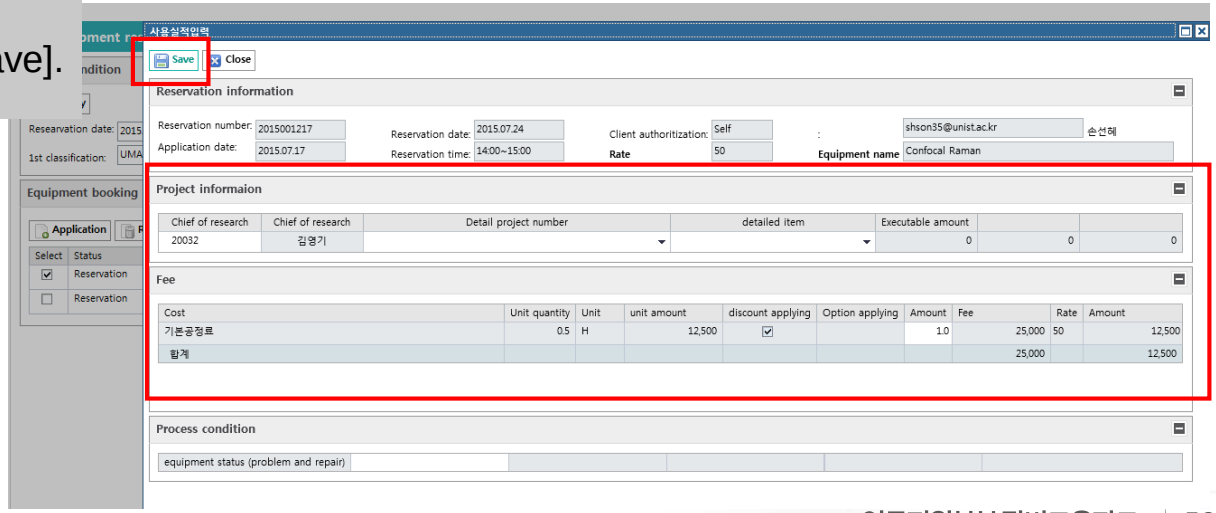
1. Select the reservation.
2. Click the [Reservation cancel].

Input result

After measurement, you have to input result instead of filling in log sheet



1. Select the reservation.
2. Click the [Input result].
3. Check the information and click [Save].



Penalty points for users of equipment

- 벌점 부과 기준

No.	벌점 부과 내용	벌점
[장비 사용 자격]		
1	해당 장비에 대하여 직접 사용이 허가 되지 않은 사용자가 기기를 사용	5
2	장비 예약하지 않고 장비 사용	3
3	장비 예약자 본인이 아닌 자가 장비를 사용	3
[장비 사용 예약]		
4	허용시간 이외의 시간에 장비 예약 및 사용	1
5	장비 예약시간을 초과하여, 예약시간 종료 전에 초과시간에 대한 예약없이 장비 사용	1
6	장비 예약 취소 사실 통보 없이 해당 시간에 장비 사용하지 않은 경우	3
7	「연구지원본부 운영지침」제7조의 내용을 기준으로, 장비 예약 취소 기한이 지나서 예약을 취소한 경우	1
8	예약 후 장비담당자에게 통보하지 않고 기기 사용	1
[부주의한 행동]		
9	장비 사용 중 허용되지 않은 기능 조작	3
10	장비 사용 중 장비의 이상이나 고장 발견 후 담당자에게 즉시 고지하지 않은 경우	3
11	사용자 부주의로 기기 손상 및 고장	5
12	사용자 부주의로 장비 부속품 분실 또는 파손	5
13	장비 사용 후 장비사용일지를 작성하지 않거나 허위 작성 또는 일부만 작성	1
14	담당자가 장비 또는 시설의 정상적인 작동과 안전을 유지하는 데에 반드시 파악해야할 시료의 정보를 제공하지 않아 장비 손상 및 고장을 초래	3
15	야간 또는 장비 담당자의 정규 근무시간이 아닌 때에 장비 사용 후 소등. 출입문단속. 주변 정리 등을 확인하지 않고 퇴실	3
16	유독 물질 및 가스의 누출 또는 화재 발생의 위험을 초래	5
17	타인의 개인물품(분석 및 공정 소모품 및 기자재)을 사전 동의 없이 사용하거나 훔치는 행위	5

Penalty points for users of equipment

- Penalty points criteria

No.	Behaviors subject to penalty points	Penalty pts.
[Eligibility to use equipment]		
1	Unauthorized use of equipment without permission	5
2	Use of equipment without a reservation	3
3	Someone other than the equipment lessee used the equipment	3
[Reservations for using equipment]		
4	Reserved and used equipment outside of permitted hours	1
5	Use of equipment beyond the time reserved without making another reservation beforehand for extra time	1
6	Failed to use the equipment durng the reserved time and did not cancel reservation in advance	3
7	Cancelling reservations for equipment after the cancellation deadline, under Article 7, Guideline for the Operation of the UNIST Central Research Facilities (UCRF)	1
8	Use of any equipment without giving a prior notice to the equipment manager, after making a reservation	1
[Careless behaviors]		
9	Using functions on the equipment that are not permitted	3
10	Failure to promptly notify the manager of any errors or failures detected during use	3
11	Negligence that resulted in damages or failure to the equipment	5
12	Negligence that resulted in loss or damage to an equipment component or part	5
13	Failure to record in the equipment usage log after using any equipment, or misrepresentation or partial representation of the facts	1
14	Failure to provide specimen information required by the equipment manager to ensure normal operations and safety of equipment or facilities, thus resulting in damage or failure to the equipment	3
15	Leaving the laboratory without putting the laboratory back in order, without turning off the lights, or without properly locking the entrance door, after using equipment at nighttime or during the equipment manager's off-hours	3
16	Causing leakage of toxic substances, gases, or causing risk of fire	5
17	Using or stealing someone's personal items (e.g. supplies, equipment or materials for analysis and process) without prior consent	5

Penalty points for users of equipment

- Follow-up Actions after Imposing Penalty Points

구분	벌점	조치내용
[장비사용자 개인]		
개인에게 부과된 벌점 합산	≥ 5 points	장비 담당자가 사용자 및 지도교수에게 이메일로 통보(벌점 8점 이상일 시 장비 사용이 3개월간 금지됨을 공지)하고 해당 사용자의 벌점 내역을 기기실에 게시
	≥ 8 points	장비 담당자가 사용자 및 지도교수에게 사용자의 해당 장비 사용이 3개월간 금지되고 재교육 후 사용이 가능함을 이메일로 통보하고 지도교수에게 공문 발송, 해당 사용자의 벌점 내역을 기기실에 게시
(사용자 소속 연구실)		
동일 연구실에서 동일 장비에 대하여 연구실 소속 학생들에게 부과된 벌점 합산	≥ 12 points	장비 담당자가 지도교수와 해당 사용자에게 벌점 15점 이상일 시 해당 연구실의 해당 장비 사용이 3개월간 금지됨을 이메일로 통보
	≥ 15 points	장비 담당자가 지도교수에게 해당 연구실의 해당 장비 사용이 3개월간 금지됨을 이메일로 통보, 지도교수에게 공문 발송, 해당 사용자의 벌점 내역을 기기실에 게시
동일 연구실에서 연구지원본부 전체 장비에 대하여 연구실 소속 학생들에게 부과된 벌점 합산	≥ 20 points	연구지원본부에서 지도교수와 소속 학생에게 벌점 25점 이상일 시 해당 연구실의 연구지원본부 전체 장비 사용이 1개월간 금지됨을 이메일로 통보
	≥ 25 points	연구지원본부에서 지도교수와 소속 학생에게 해당 연구실의 연구지원본부 전체 장비 사용이 1개월간 금지됨을 이메일로 통보, 지도교수에게 공문 발송, 해당 벌점 내역을 연구지원본부 게시판에 게시

Penalty points for users of equipment

- Follow-up Actions after Imposing Penalty Points

Classification	Penalty pts.	Follow-up actions
(Individual users of equipment)		
Sum up penalty points imposed to individuals	≥ 5 points	Equipment manager will notify user(s) and their supervising professor by email of their penalty points total, and shall post the details of their penalty points on the bulletin board of the equipment room. Users with penalty points 8 points or higher may not use the relevant equipment for 3 months.
	≥ 8 points	Equipment manager will notify user(s) and their supervising professor by email that the user(s) may not use the relevant equipment for 3 months until they complete the re-orientation course; will also forward an official notice to their supervising professor; and will post details of their penalty points on the bulletin board of the equipment room.
(User's laboratory)		
Sum up penalty points imposed on the students in the laboratory for the same equipment in the same laboratory	≥ 12 points	Equipment manager will notify the user(s) and their supervising professor by email that user(s) with penalty points 15 points or higher may not use the relevant equipment in the laboratory for 3 months.
	≥ 15 points	Equipment manager will email the supervising professor to inform that the user(s) may not use the relevant equipment in the laboratory for 3 months; will also forward an official notice to their supervising professor; and will post the details of their penalty points on the bulletin board of the equipment room.
Sum up penalty points imposed on the students in the laboratory for all UCRF equipment in the same laboratory	≥ 20 points	UCRF will notify students and their supervising professor by email that the user(s) with 25 penalty points or higher may not use any UCRF equipment in the laboratory for 1 month.
	≥ 25 points	UCRF will notify students and their supervising professor by email that user(s) may not use any UCRF equipment in the laboratory for 1 month; will also forward official notice to their supervising professor; and will post details of their penalty points on the bulletin board of UCRF.

9. Basic information

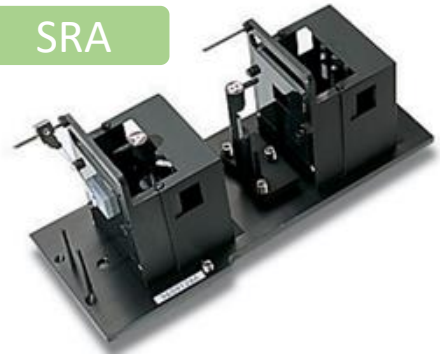
-자산 정보

-담당자

UV-Vis-NIR Instrument – NSB B111

DRA

SRA



VASRA

Specifications

- Model : Cary 5000
- Wavelength range :175 ~ 3,300 nm
- Source
  - UV (200 ~ 350 nm) : D2 lamp
  - Vis-NIR (350 ~ 3,300 nm) : W lamp
- Monochromator : double out of plane Littrow
- Detector
  - UV-Vis : PMT
  - NIR : Pbs
- Resolution
  - UV-Vis < 0.048 nm
  - NIR < 0.2 nm
- Accuracy
  - ±0.08 nm @ 190 ~ 900 nm
  - ±0.4 nm @ 760 ~ 3,000 nm

Information

☐ 국가연구시설장비 정보 등록증

고정자산관리번호	14006691/14006692	연구시설, 장비 구분	주장비
취득 방법	구매	모델명	Cary 5000
제작사	Agilent Technologies	제작 국가	미국
취득금액 (원)	71,336,491 원 71,336,491 원	취득일자	2012-10-09
활용 범위	공동활용서비스 가능	장비용도	분석
장비 등록 번호	NFEC-2012-09-171100 NFEC-2012-10-171726	등록 일자	2012-10-10
한글명	자외선/가시광선/근적외선 분광광도계		
영문명	UV-Vis-NIR		

☐ 연구시설·장비의 운영 인력

성명	소속부서명	연락처 (사무실)	이메일
조미선	연구지원본부	052-217-4034	shail019@unist.ac.kr

☐ Witec Application Specialist

성명	소속부서명	직급	연락처	이메일
임근태	Agilent Technologies	차장	02-2004-5090	geun-tae.im@agilent.com

10. Emergency

-장비 작동

-연락 체계

Emergency

연구실 번호 (Laboratory No.)	자연과학관 B111호
연구실명 (Laboratory Name)	통합실 Laboratory
연구실 안전담당자 (Safety Manager)	Mi-Sun Cho 내선(Extension) (4034) ★ Please do not hesitate to contact "Safety Manager", if you have any queries or urgent business. (문의 사항 또는 급한 용무가 있을 시, "연구실 안전담당자"에게 연락 요망)

원외 주요 연락처

External Main Telephone

소방서 Fire Station	119
경찰서 Police Station	112
좋은삼정병원 Hospital	052)220-7500

화재,폭발,가스・화학약품누출등응급상황발생시

Fire, Explosion, Gas and Chemical Leak etc.

응급상황 발생시
Emergency Call

052) 217-0119

11. Case Study

12. References

-UNIST 연구결과
-참고논문
-웹사이트

13. External training

14. Related Equipment

ULSAN NATIONAL INSTITUTE OF SCIENCE AND TECHNOLOGY

UV-Vis Microspectrometer – NSB B111

Specifications

- Model : 20/20 PV
- Wavelength range : %T 200 ~ 1,050 nm (Xe lamp)
  %R 200 ~ 1,050 nm (Xe lamp)
  %R 200 ~ 2500 nm (Halogen lamp)
- Source : Xe lamp & Halogen lamp
- Spectral bandwidth : 0.32 nm
- Full range single scan time : 7 msec
- Image resolution : more than 1 Mpixel
- Mode : absorbance, transmittance, reflectance

Applications

- Microscale characterization
- Micro-contaminant identification
- Identifying protein, DNA, RNA crystals

15. Attachments

ULSAN NATIONAL INSTITUTE OF SCIENCE AND TECHNOLOGY

UV-Vis-NIR accessories

1. Specular Reflectance – coatings
    - Variable Angle Reflectance (VASRA)
    - Double beam Absolute Reflectance (VW SRA)
    - Fixed Angle Specular Reflectance

2. Diffuse Reflectance
    - Internal/External DRA
    - Praying Mantis – low volume powders
    - Cricket
    - Reference beam access (Ext. DRA) - kinetics

UV-Vis-NIR accessories

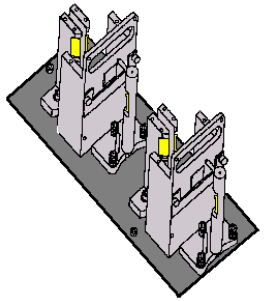
3. Transmission
   - Brewster Angle – polarized optics
   - Variable angle transmission holder
   - Solid sample holder – Sub-nanometer filters, thin films
   - DRA Centre Mounting (Ext. DRA) – turbid solutions
   - Cryogenics – low temp crystal studies

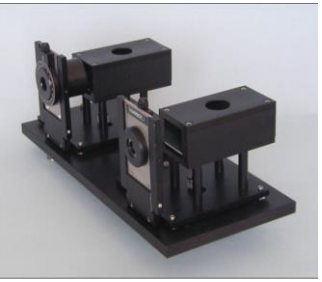
4. Liquid Handling
   - Peltier 6x6 and 1x1 Accessories

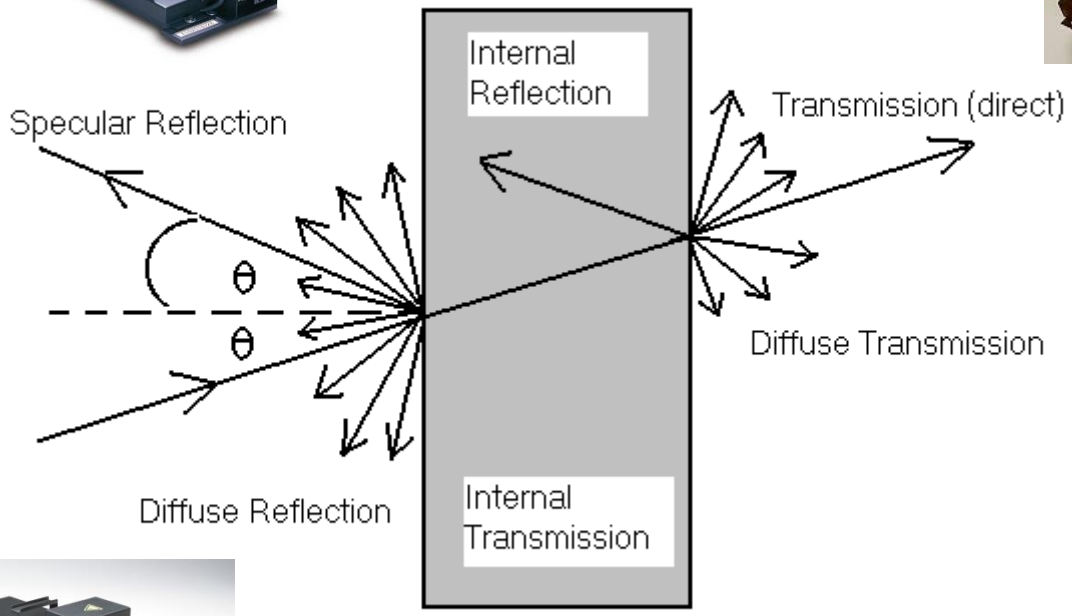
5. RBA, Polarizers/depolarizers,

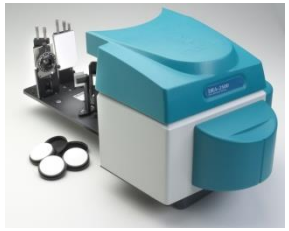
   Automated Double Aperture Photometric Accuracy Kit.

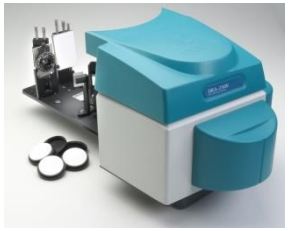
UV-Vis-NIR accessories











Bld.102

Materials Characterization lab is located underground.

UV-Vis-NIR is located in B111.