AI-MAT 2022 暑期課程

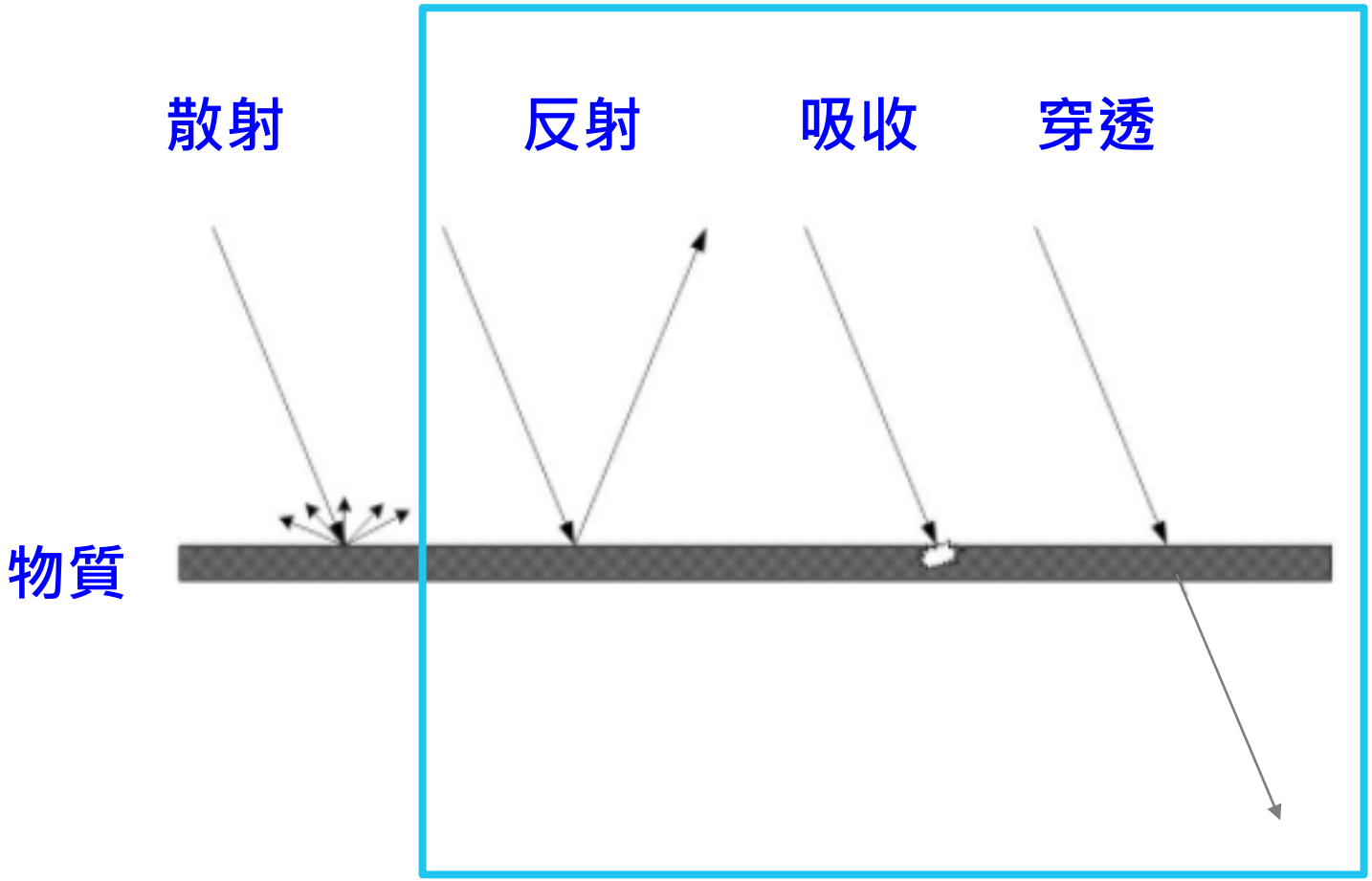
反射與穿透光譜
原理與實作

台灣大學 凝態中心 光電工坊 黃鈺淳

2022/7/7 (星期四)

台灣大學 凝態中心 光電工坊

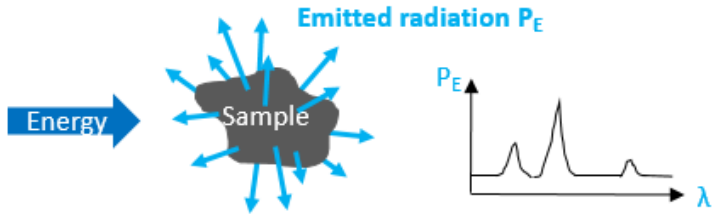
光入射物質後.....



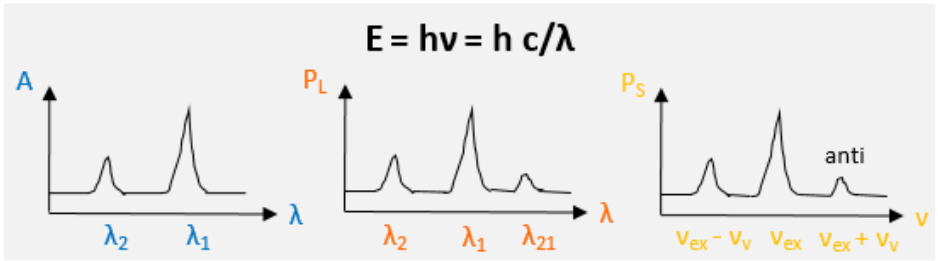
原理

Non-radiant energy — Thermal, electrical, chemical energy

Radiant energy — Electromagnetic radiation source

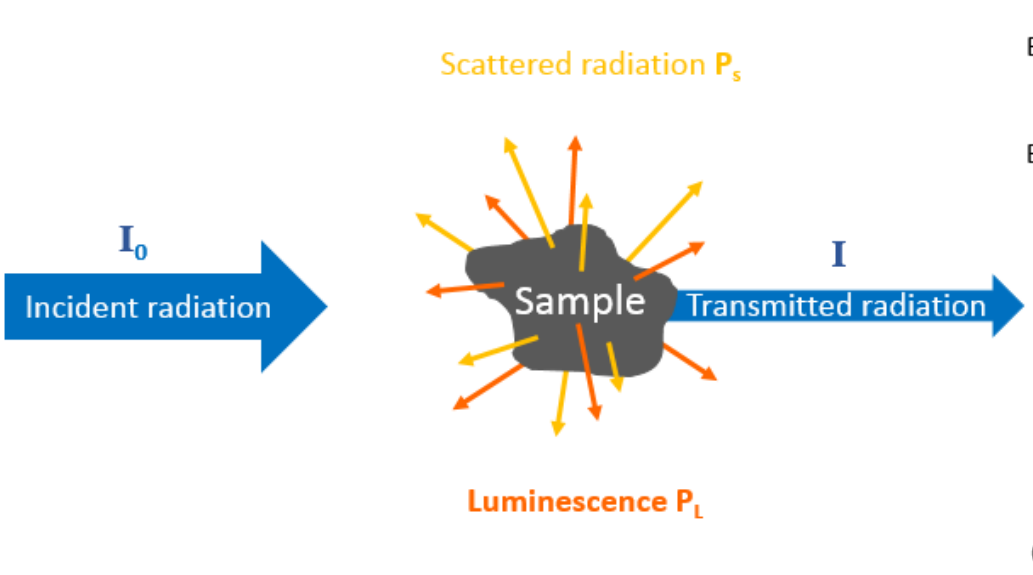


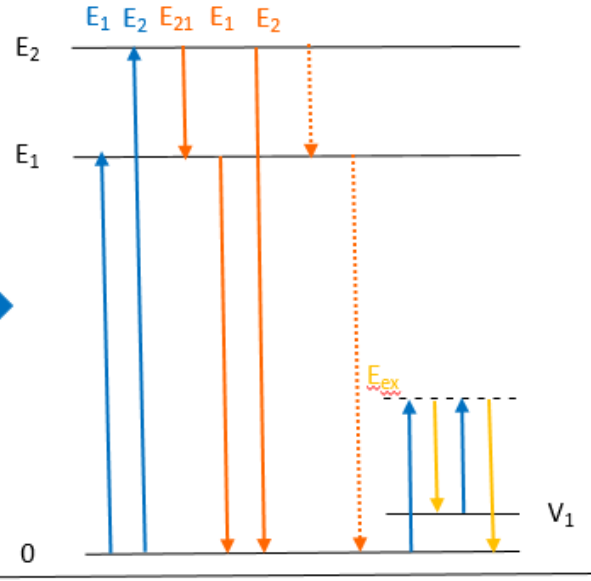
$$E = h\nu = h\,c/\lambda$$



$\sum$
- Absorbed
- Transmitted
- Reflected
- Scattered

= Incident radiation





原理

- UV-VIS Absorption Spectra :

1. Electronic spectra

- Electronic transition
  Also Vibration, Rotation transition

2. Absorption curve

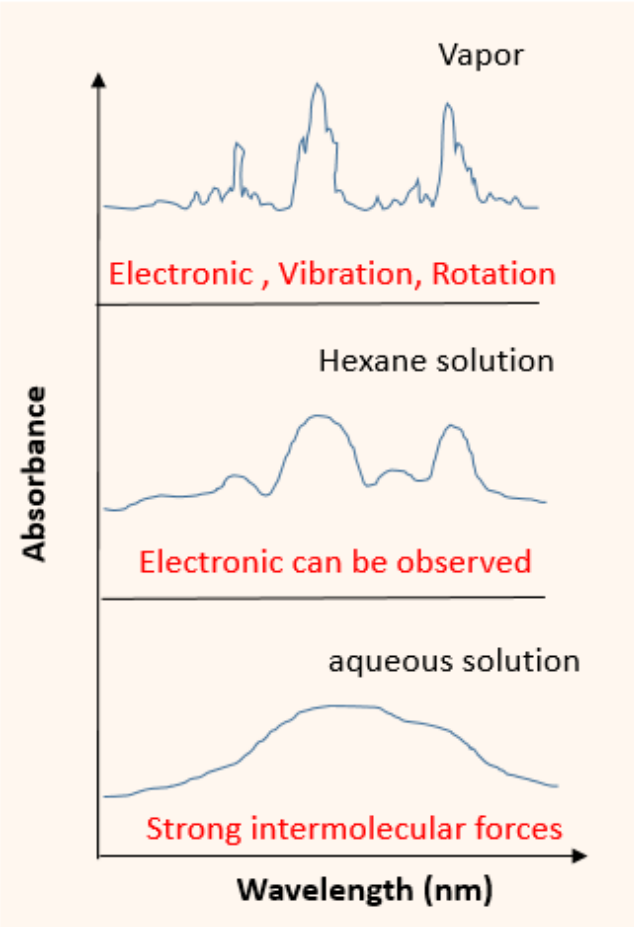
- x axis : Wavelength
- y axis : Absorbance

3. Identify sample

- Structure : Functional group
  Bonding!

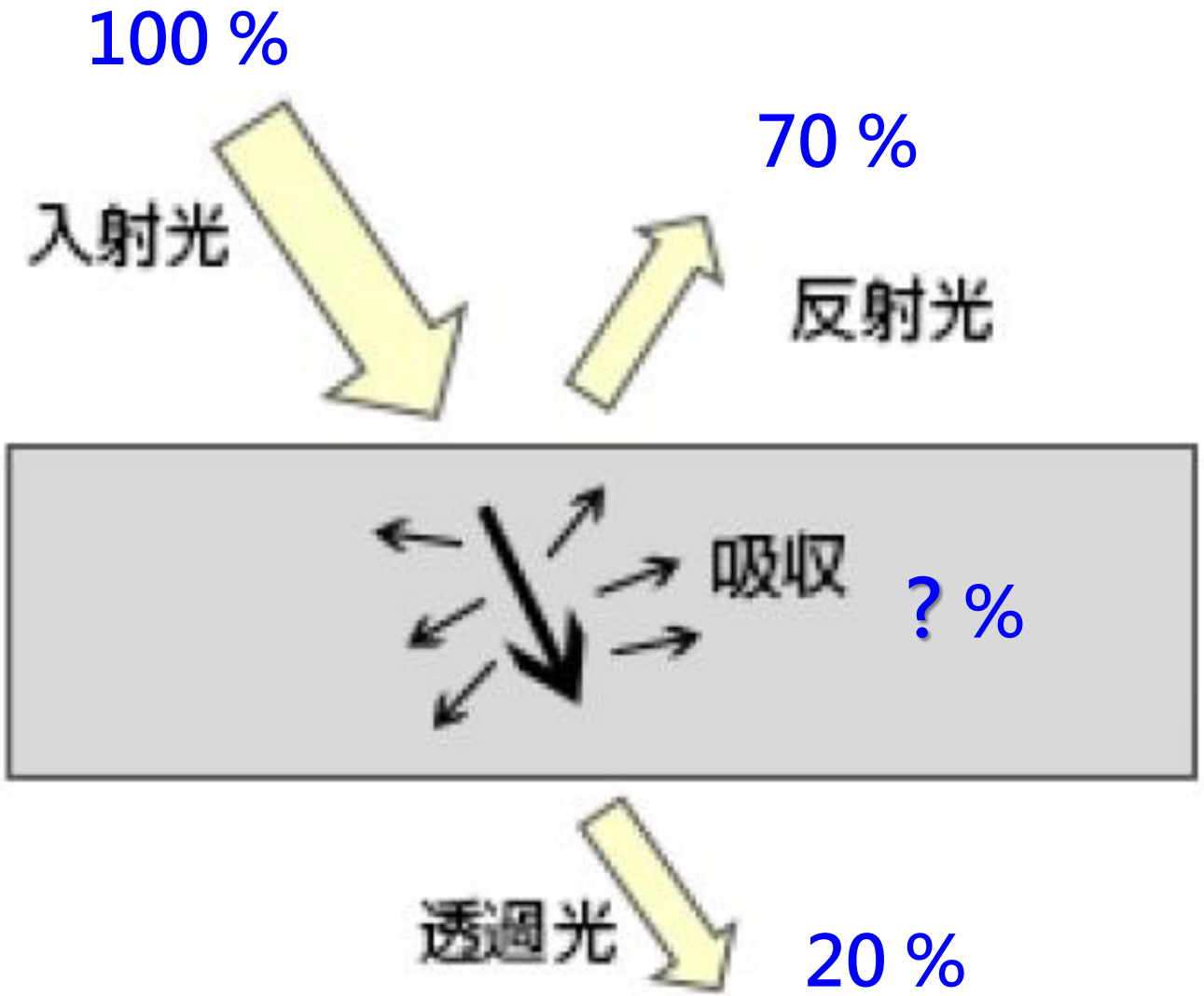
$M + h\nu \rightarrow M^*$

Relaxation
- Heat
- Luminescence
- .....

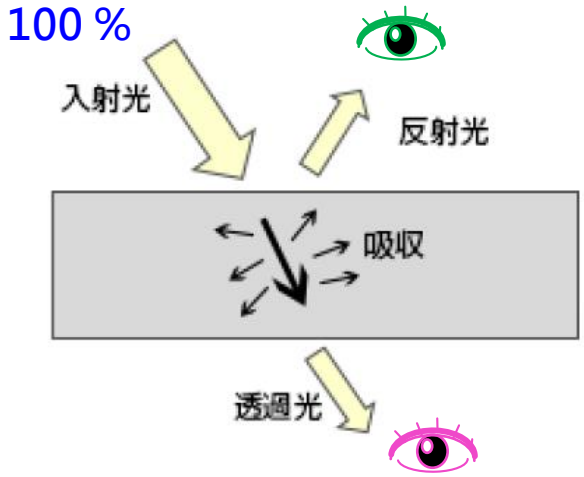


Aromatic compound : *1,2,4,5-tetrazine*

原理



名詞介紹



Transmittance / Reflectance

穿透度 / 穿透率　　反射度 / 反射率

I / I_0

30 / 100 =0.3

Absorptance

吸收率

$(I_0 - I) / I_0$

(100-30) / 100 =0.7

Absorbance = Optical density

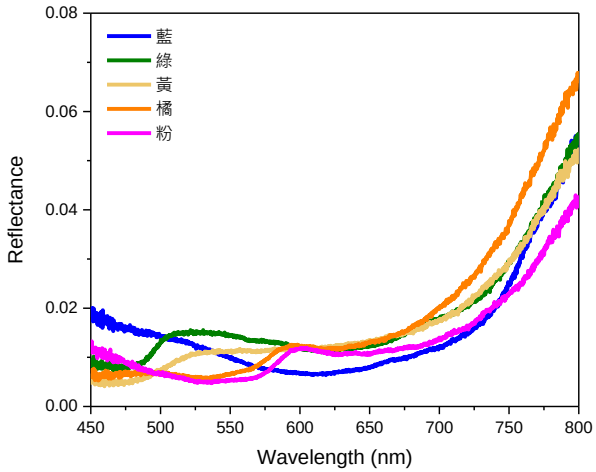
吸收度　　光學密度

$-\log (I / I_0)$

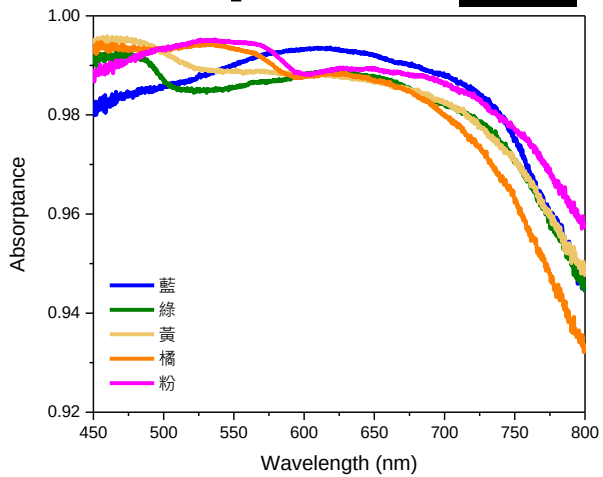
-log 0.3 = 0.5228...

光譜介紹

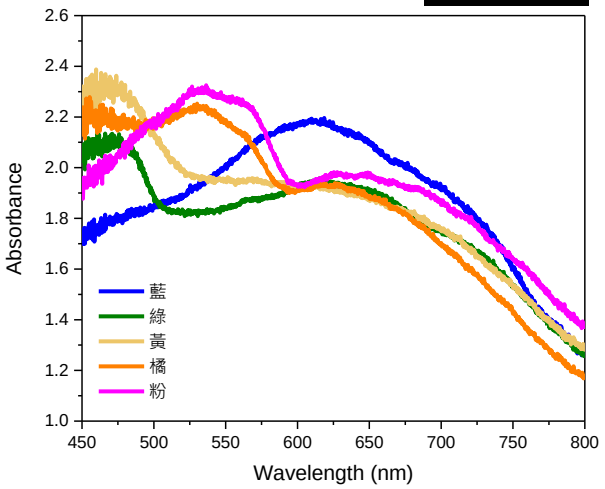
Transmittance / Reflectance T



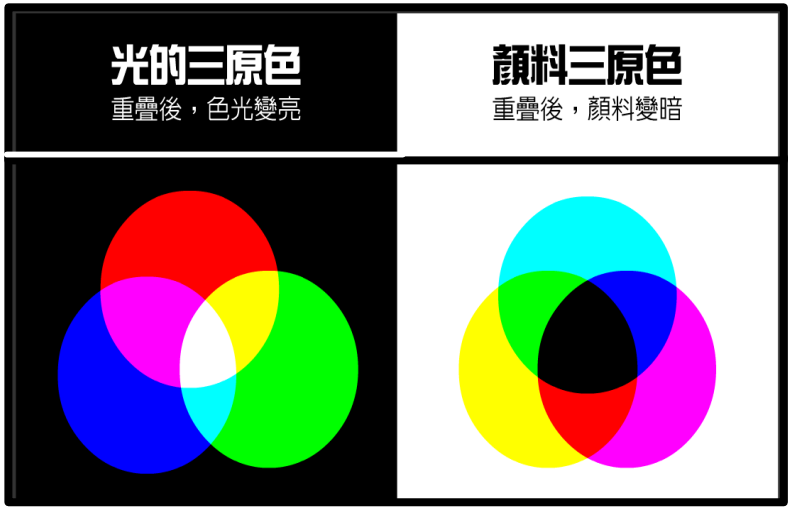
Absorptance 1-T

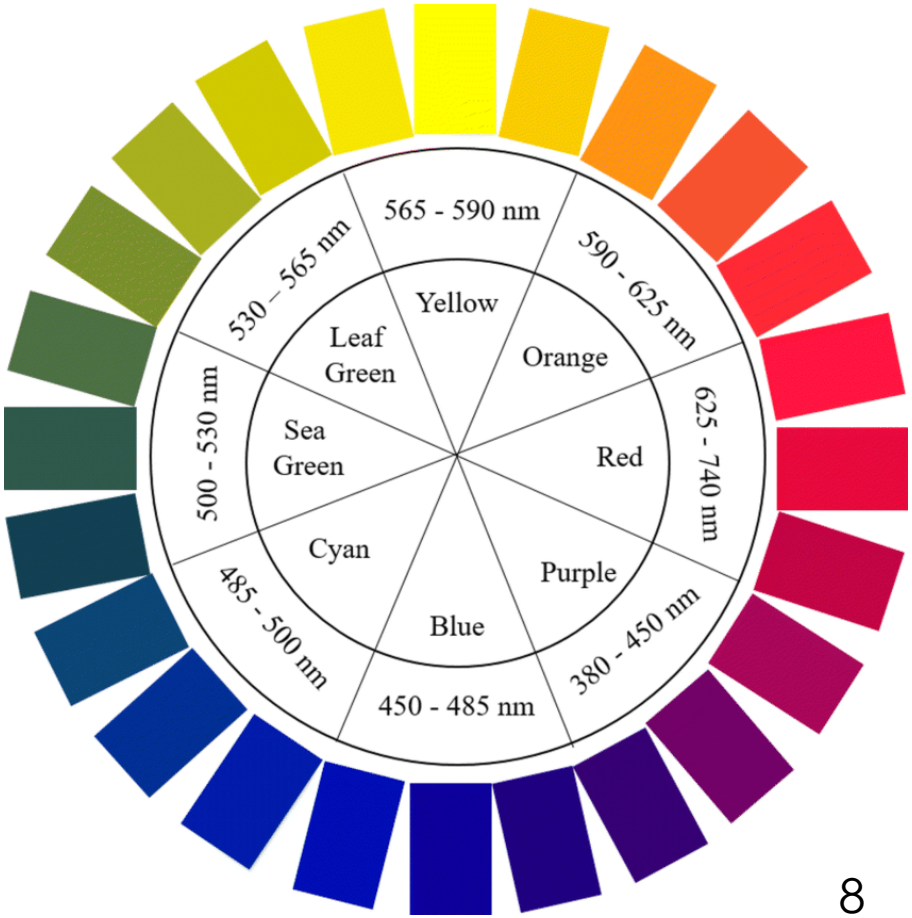


Absorbance -logT

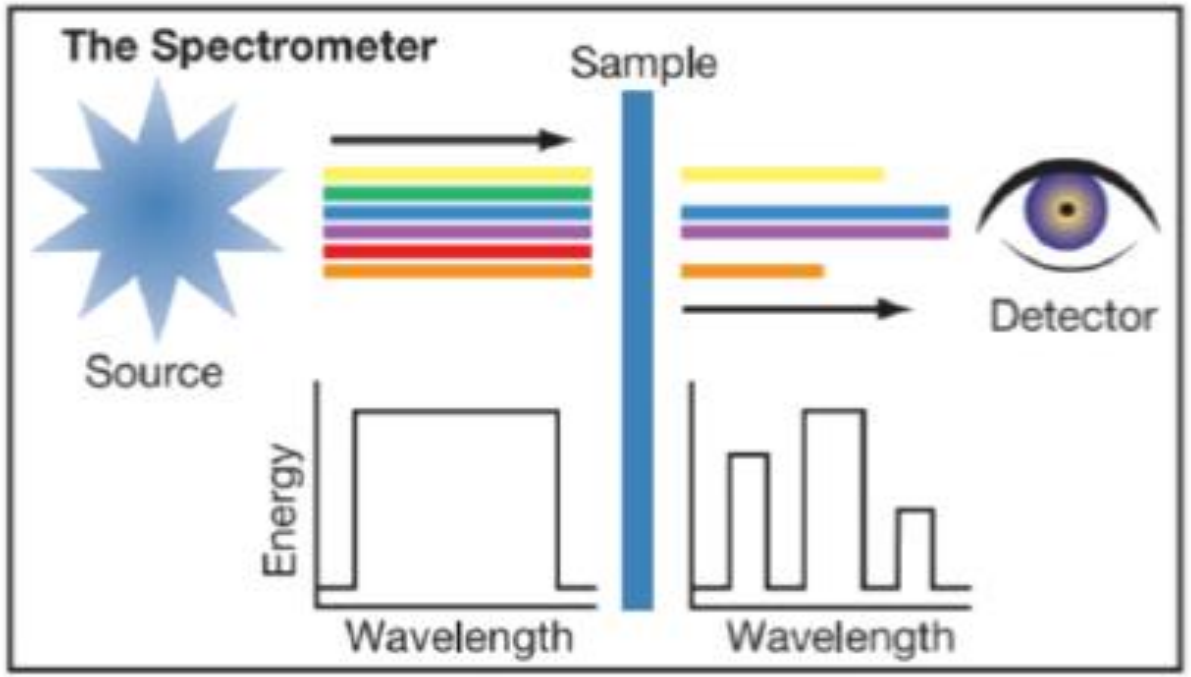


白光的組成


光的三原色
重疊後，色光變亮
顏料三原色
重疊後，顏料變暗


565 - 590 nm
590 - 625 nm
625 - 740 nm
380 - 450 nm
450 - 485 nm
485 - 500 nm
500 - 530 nm
530 – 565 nm
Yellow
Orange
Red
Purple
Blue
Cyan
Sea Green
Leaf Green

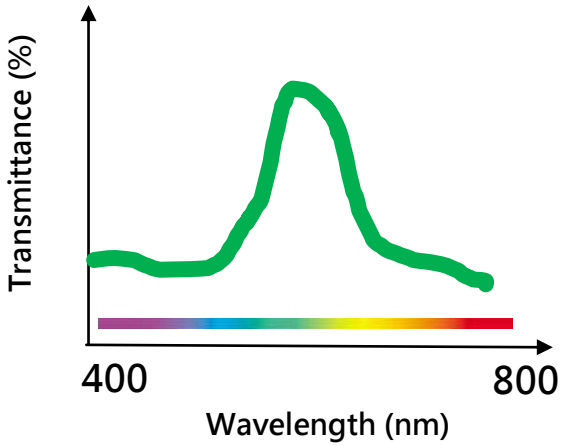
穿透、反射系統總概念


The Spectrometer
Sample
Source
Detector
Energy
Wavelength
Wavelength

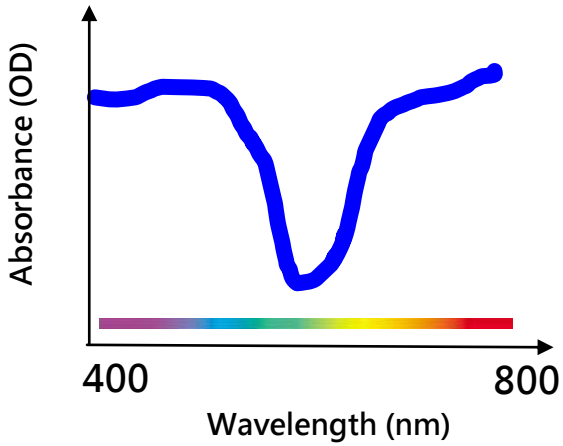

?

光譜種類

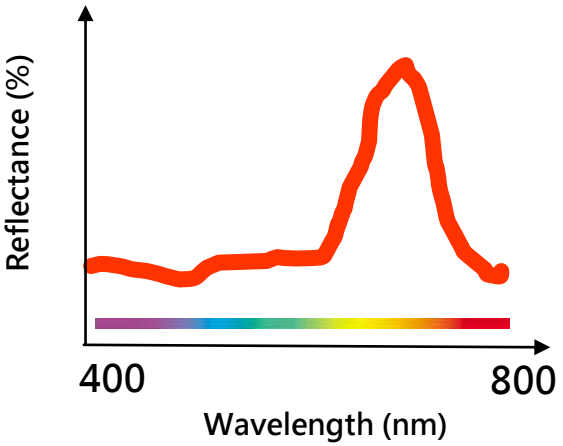
吸收光譜



穿透光譜

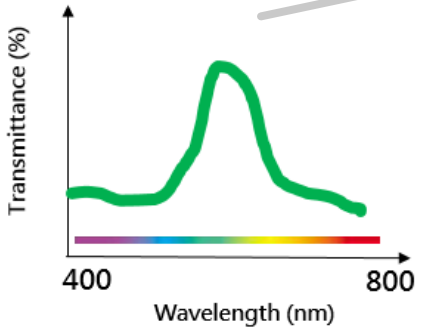


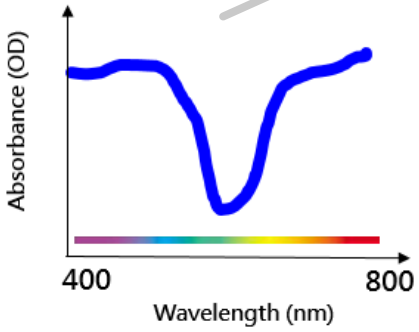
反射光譜

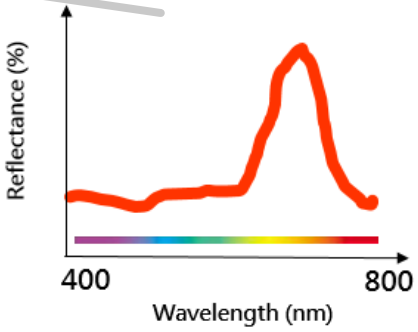


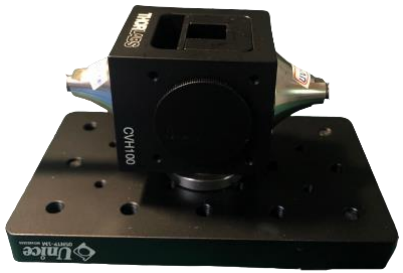
模組選擇

Filter





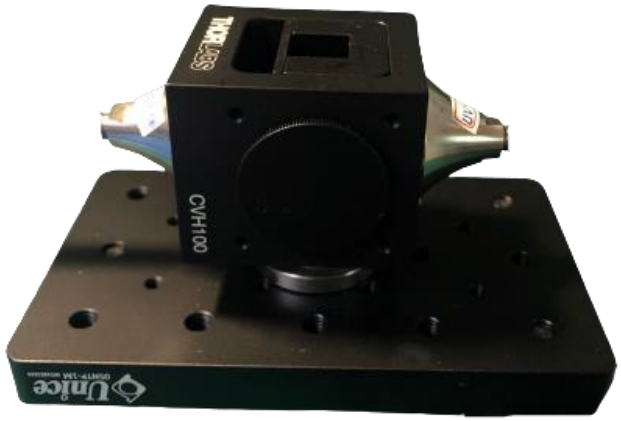


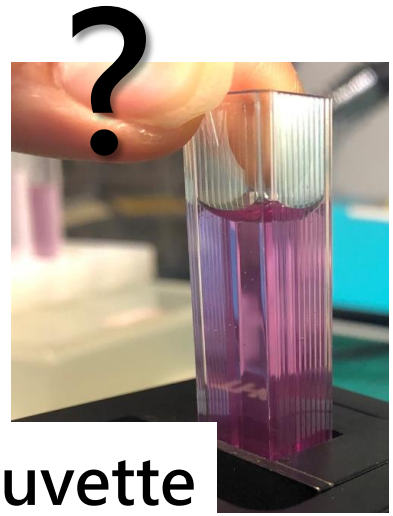


穿透模組

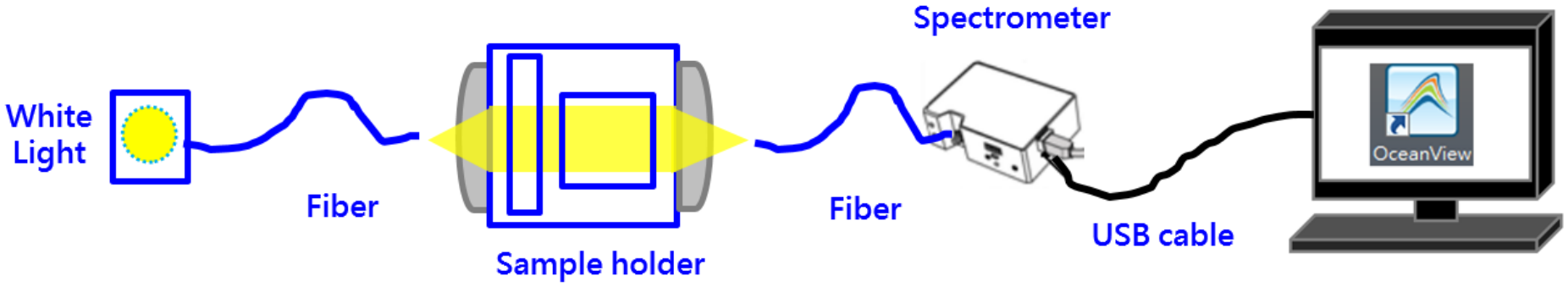
反射模組

穿透模組

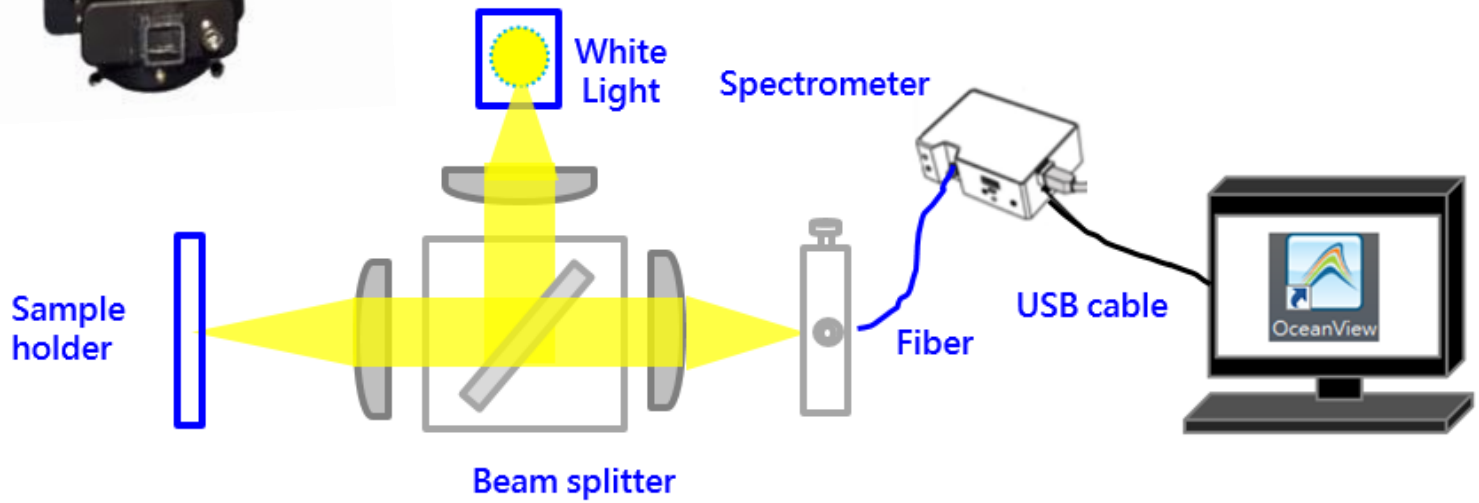




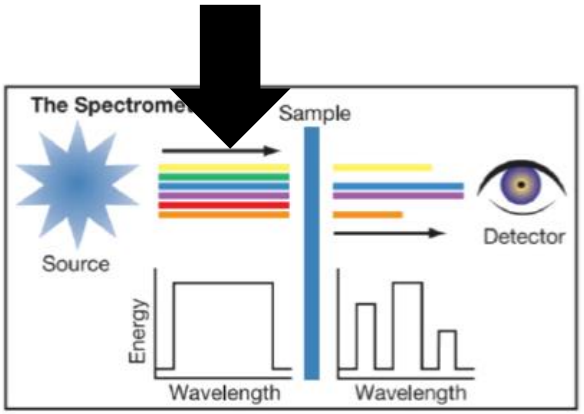
cuvette

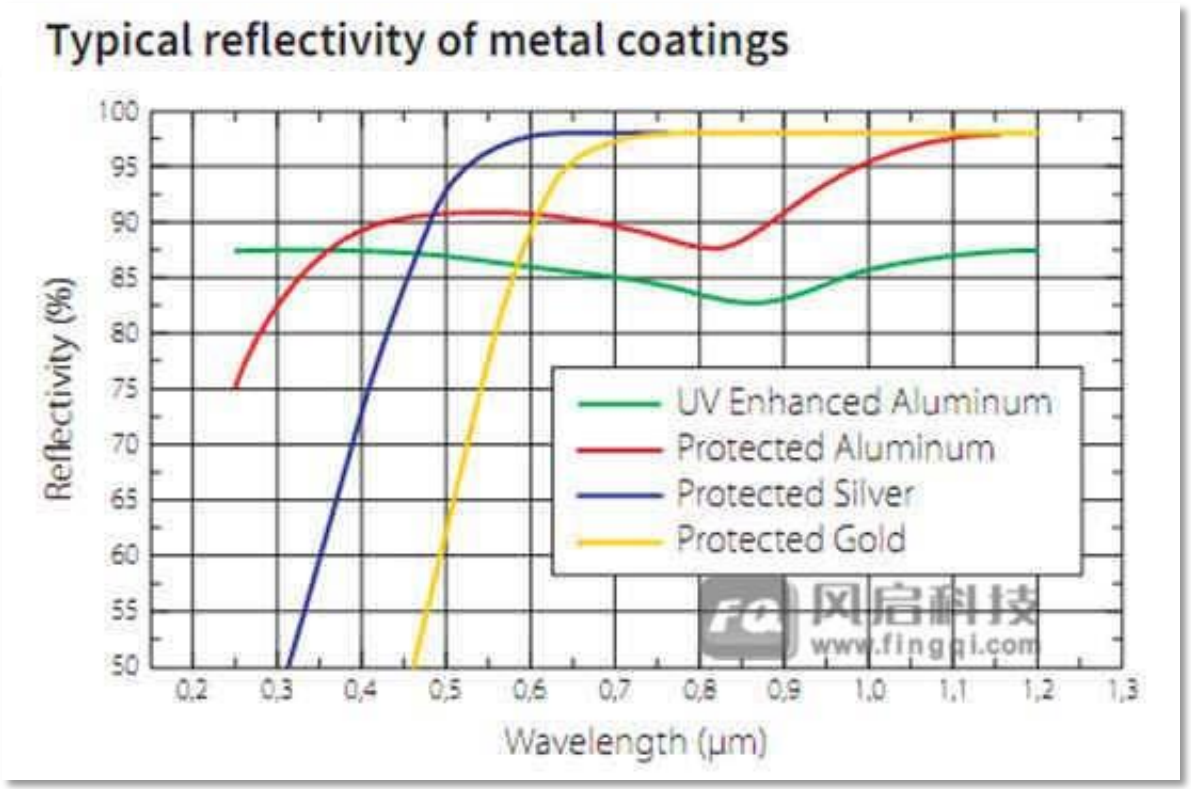


反射模組

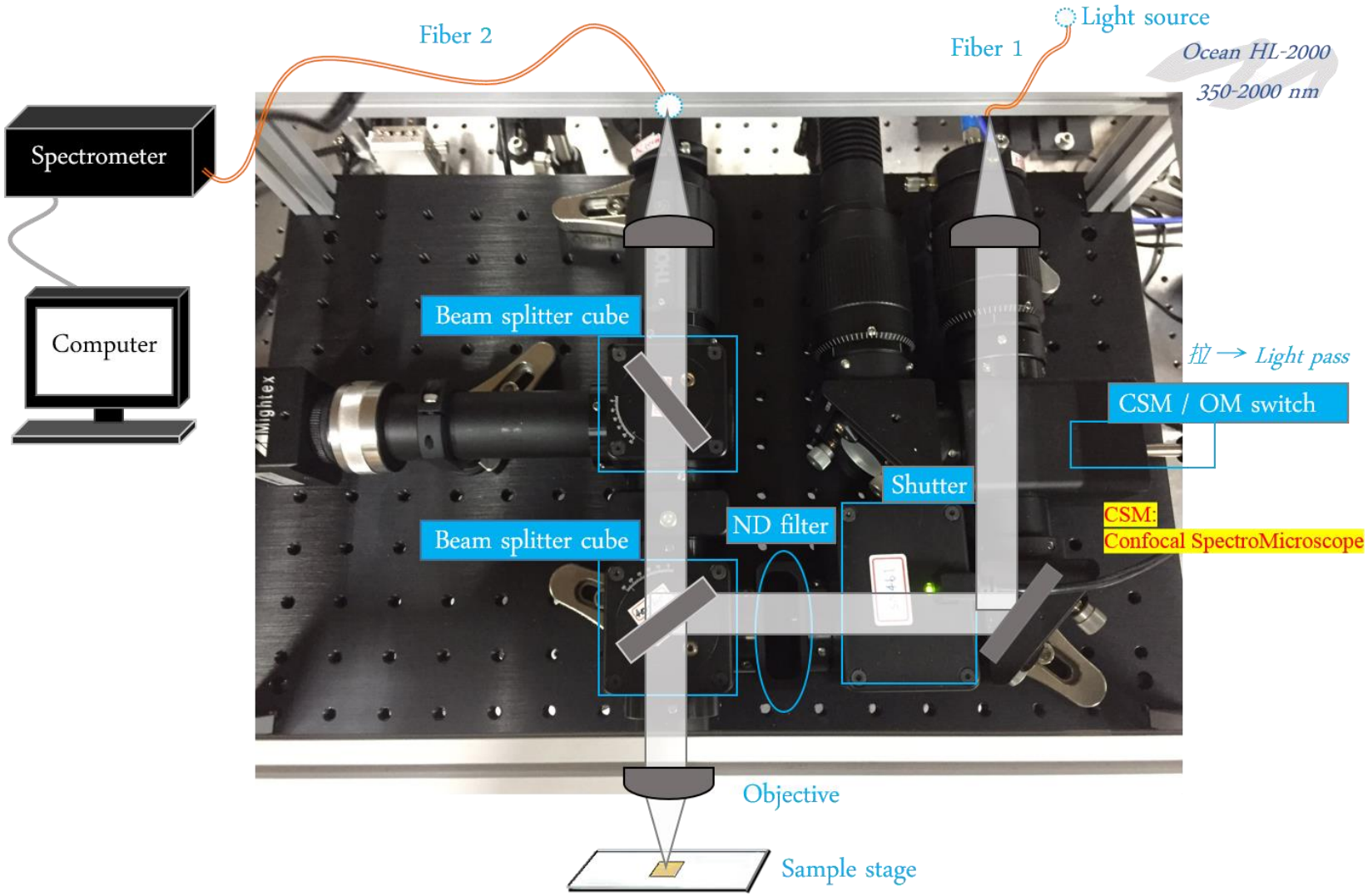

White
Light
Spectrometer
Sample
holder
Fiber
USB cable
OceanView
Beam splitter

金屬膜的反射

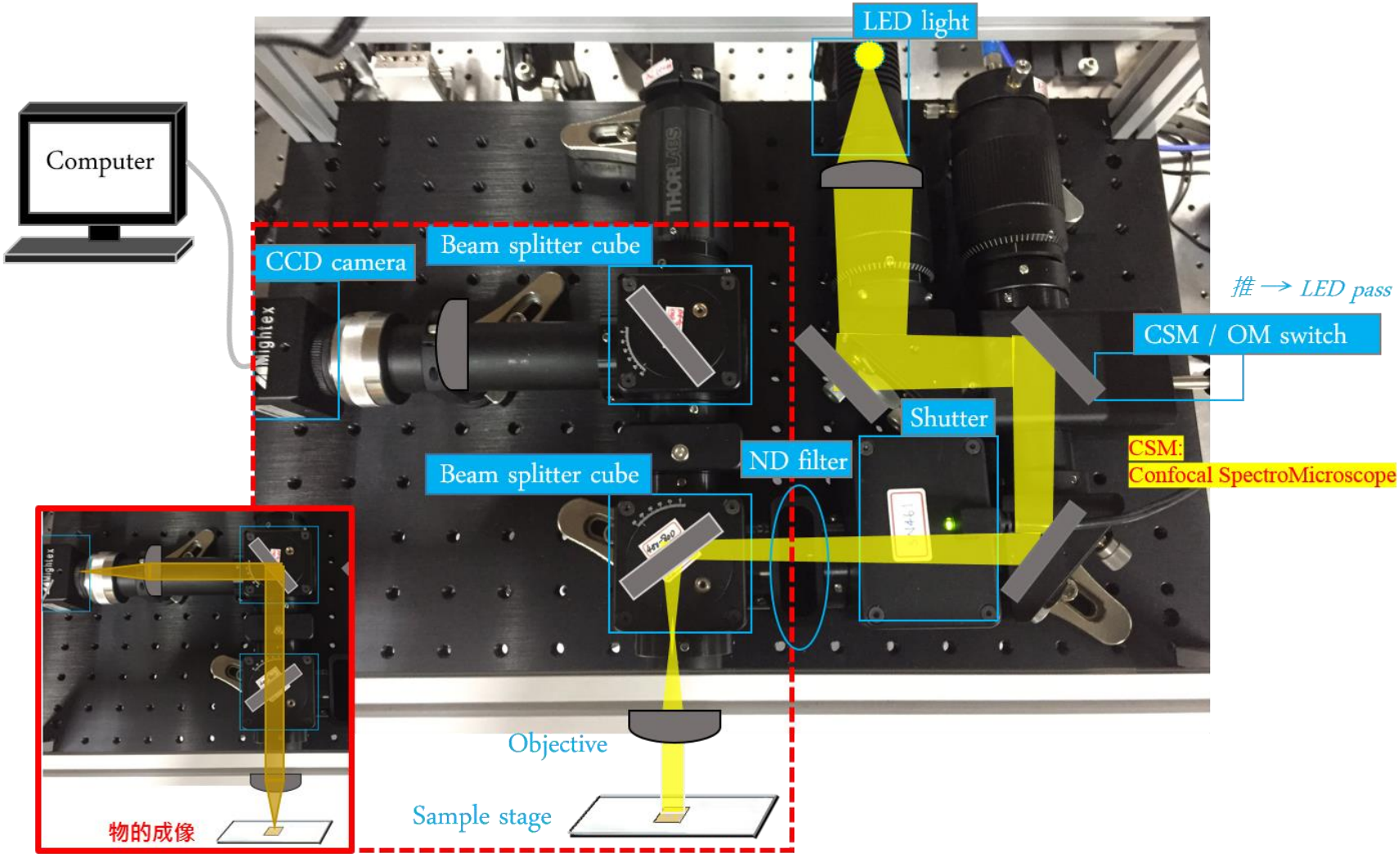

Sample
Source
Detector
Energy
Wavelength
Wavelength


Typical reflectivity of metal coatings
Reflectivity (%)
100
95
90
85
80
75
70
65
60
55
50
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
Wavelength (μm)
UV Enhanced Aluminum
Protected Aluminum
Protected Silver
Protected Gold
风启科技
www.fingqi.com

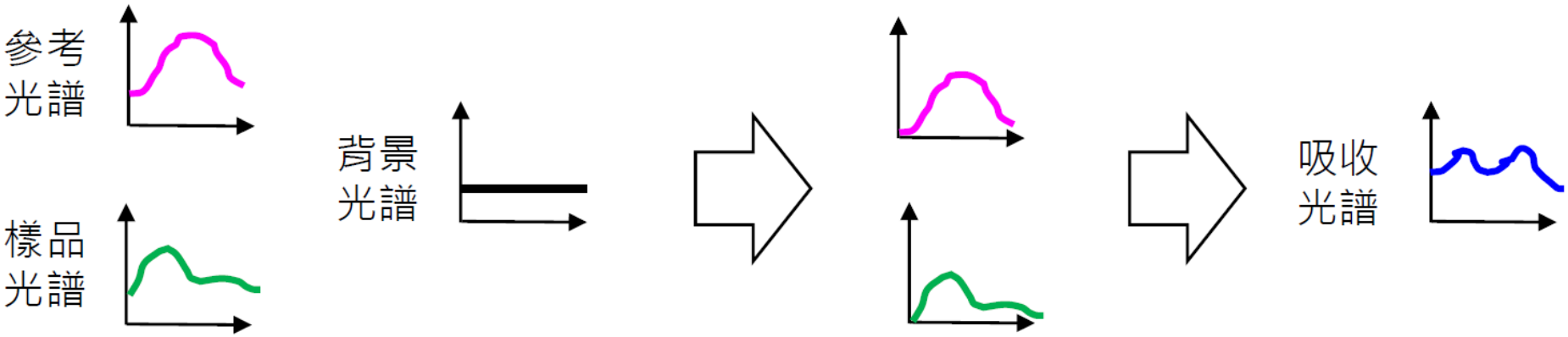
反射系統


Fiber 2
Fiber 1
Light source
Ocean HL-2000
350-2000 nm
Spectrometer
Computer
Beam splitter cube
Beam splitter cube
ND filter
Shutter
拉 → Light pass
CSM / OM switch
CSM:
Confocal SpectroMicroscope
Objective
Sample stage

反射系統


Computer
LED light
CCD camera
Beam splitter cube
推 → LED pass
CSM / OM switch
Shutter
ND filter
Beam splitter cube
CSM:
Confocal SpectroMicroscope
Objective
Sample stage
物的成像

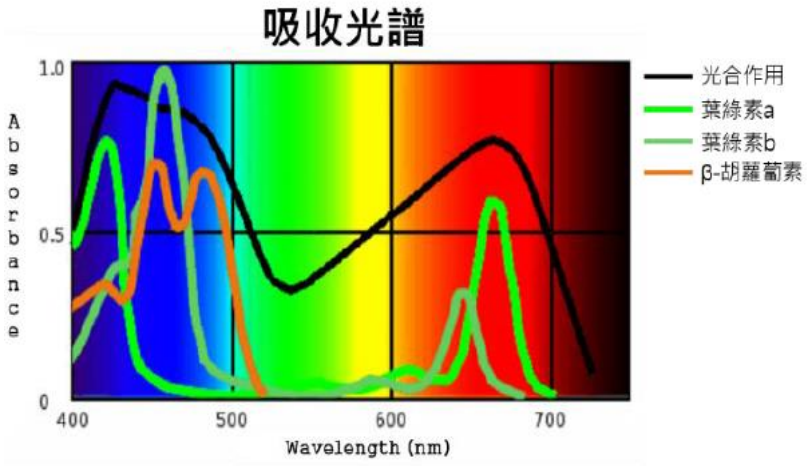
軟體操作流程

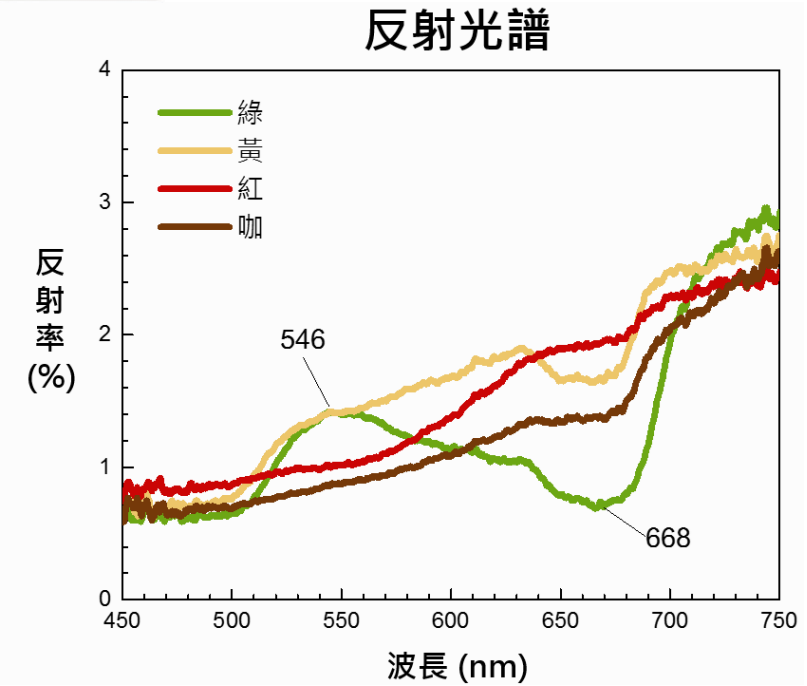


STEP 1 選擇 Transmittance 或 Absorbance 功能鍵
STEP 2 設定光譜量測**參數** (根據參考光譜調整決定)
STEP 3 儲存**參考光譜** R_f
STEP 4 儲存**背景光譜** B_g (需擋住白光)
STEP 5 完成量測前準備
STEP 6 量測**待測樣品光譜** S
STEP 7 軟體計算出待測樣品的穿透光譜 T 或吸收光譜 A

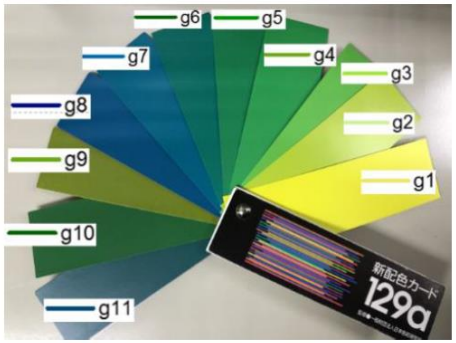
應用 (一)

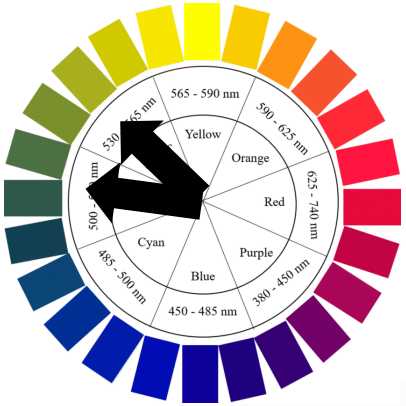

綠
黃
紅
咖


吸收光譜
Absorbance
1.0
0.5
0
400
500
600
700
Wavelength (nm)
光合作用
葉綠素a
葉綠素b
β-胡蘿蔔素

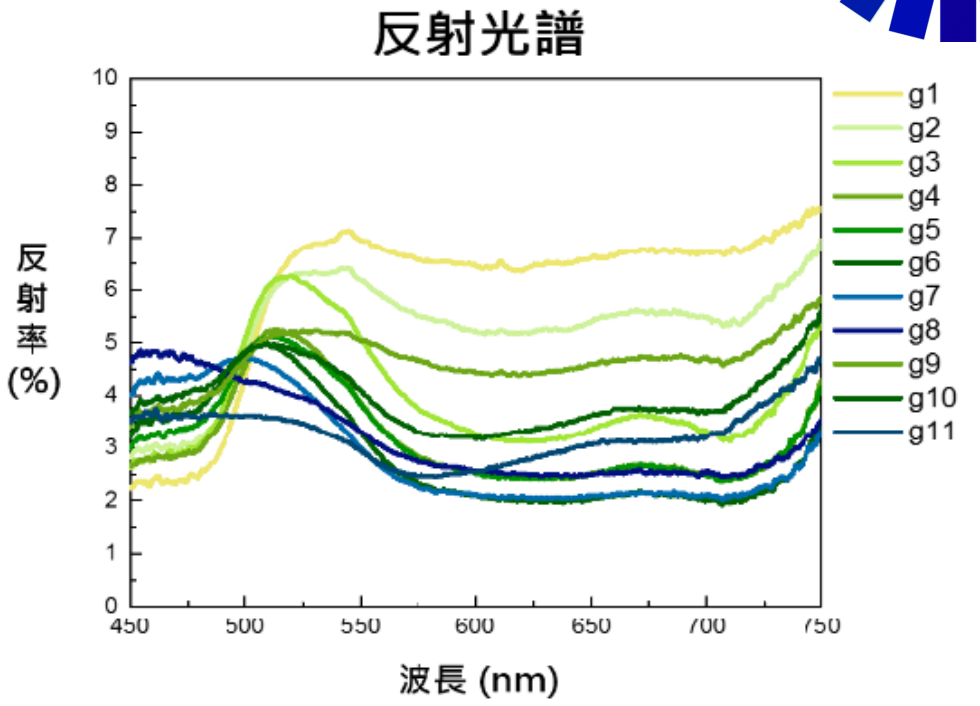

反射光譜
反射率 (%)
4
3
2
1
0
450
500
550
600
650
700
750
波長 (nm)
綠
黃
紅
咖
546
668

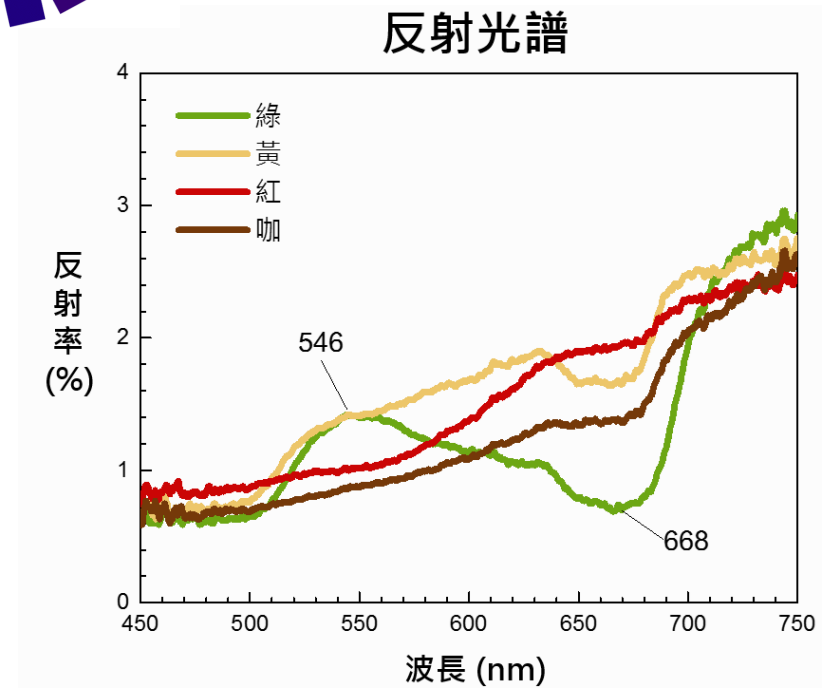
應用 (一)


g6
g5
g7
g4
g3
g8
g2
g9
g1
g10
新配色カード
129a
g11


565 - 590 nm
590 - 625 nm
625 - 740 nm
380 - 450 nm
450 - 485 nm
485 - 500 nm
500 - 520 nm
520 - 565 nm
Yellow
Orange
Red
Purple
Blue
Cyan


綠
黃
紅
咖


反射光譜
反射率 (%)
波長 (nm)
g1
g2
g3
g4
g5
g6
g7
g8
g9
g10
g11


反射光譜
反射率 (%)
波長 (nm)
綠
黃
紅
咖
546
668

應用 (二)

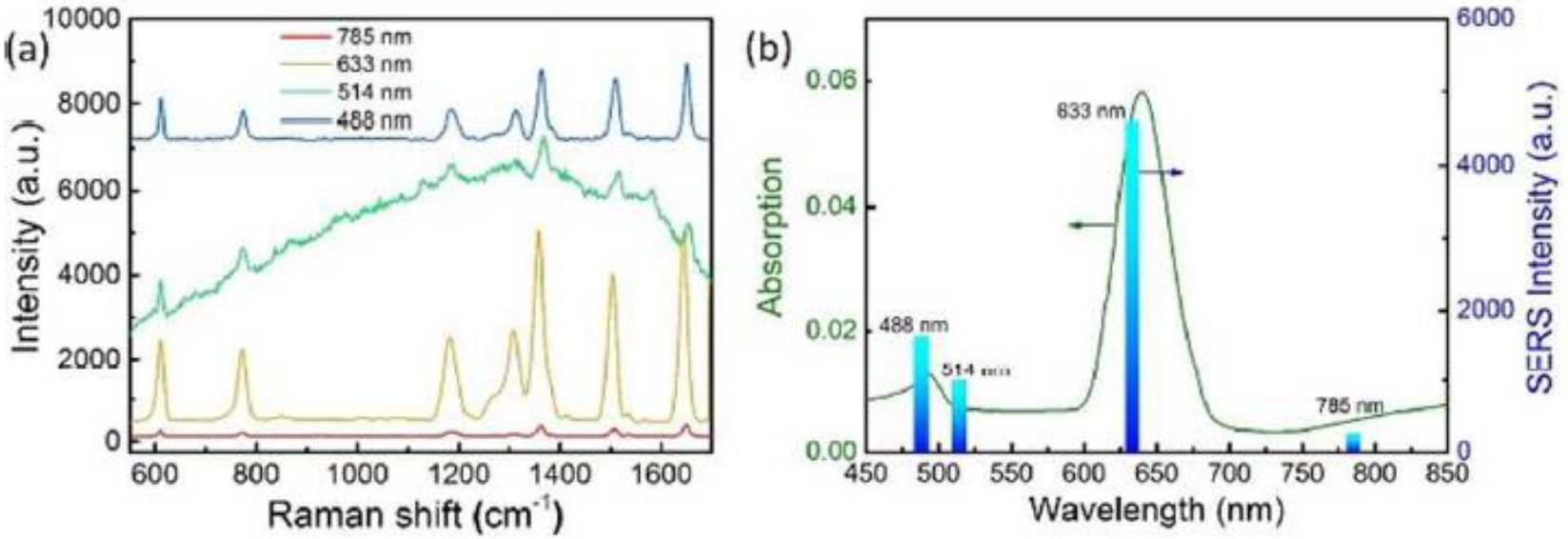


Figure 4 (a) SERS spectra of R6G at concentration of 10^{-12} M absorbed on 0.35 Ag-Au SAMCs under the different excitations of 488, 514, 633 and 785 nm respectively. (b) UV-vis spectra of 0.35 Ag-Au SAMCs and the SERS intensity of R6G (10^{-12} M) at peak 1650 cm^{-1} obtained from 0.35 Ag-Au SAMCs under the different excitations of 488, 514, 633 and 785 nm, respectively. SERS spectra of (c) R6G and (d) thiram in various concentrations obtained from 0.35 Ag-Au SAMCs under the excitation of 633 nm.

應用 (三)

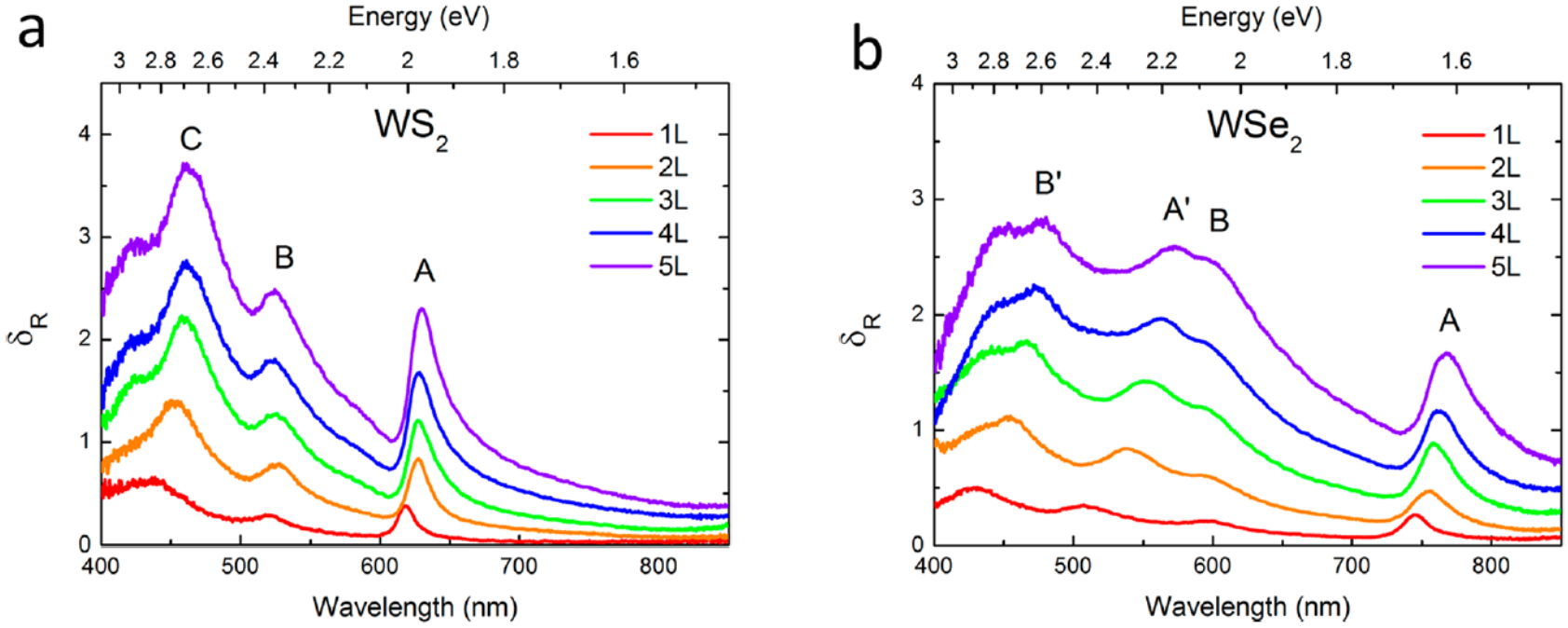


Figure 1. Differential reflectance spectra of mechanically exfoliated (a) 2H-WS_2 and (b) 2H-WSe_2 flakes consisting of 1–5 layers. The peaks are labeled according to the convention proposed by Wilson and Yoffe.[22]