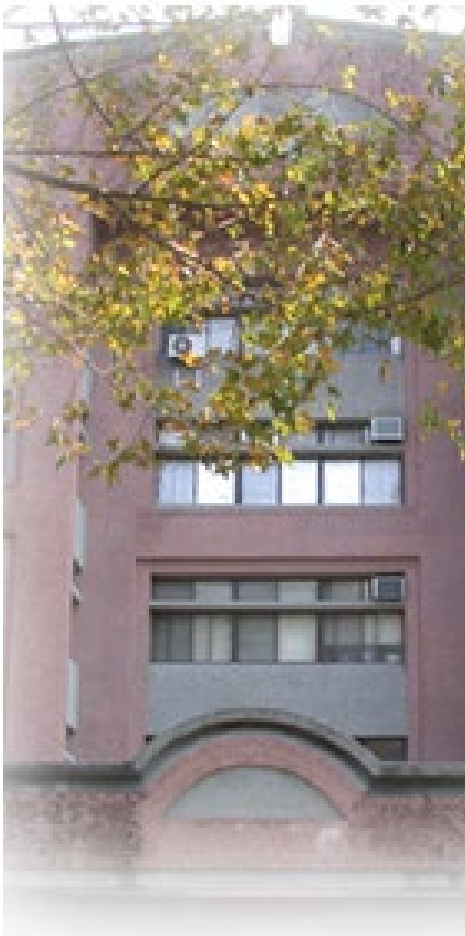


台大電機系 光電實驗



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實驗四. 電光調變器實驗

實驗六. 液晶與偏振實驗

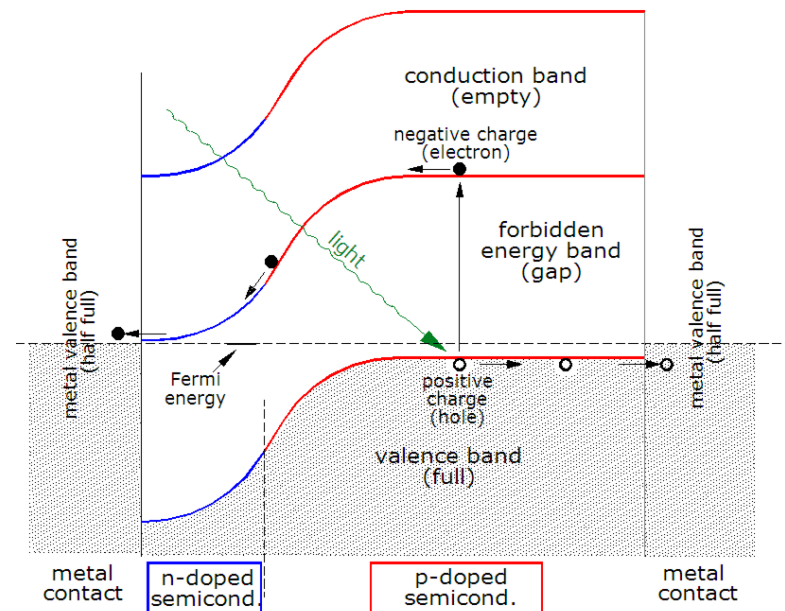
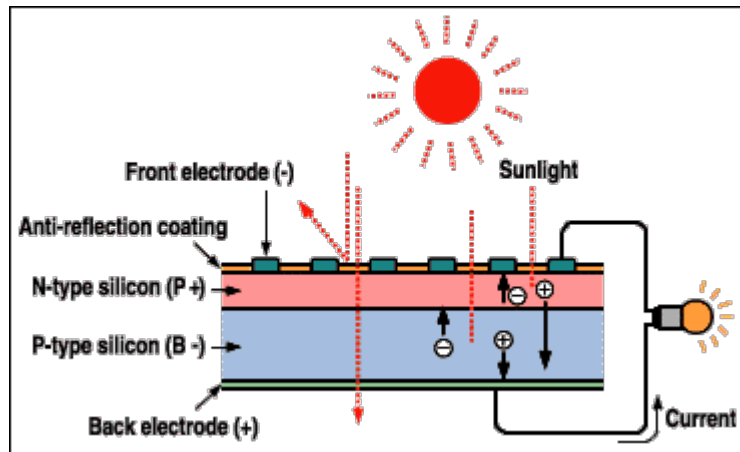
實驗七. 光纖光學實驗

實驗八. 太陽能電池實驗

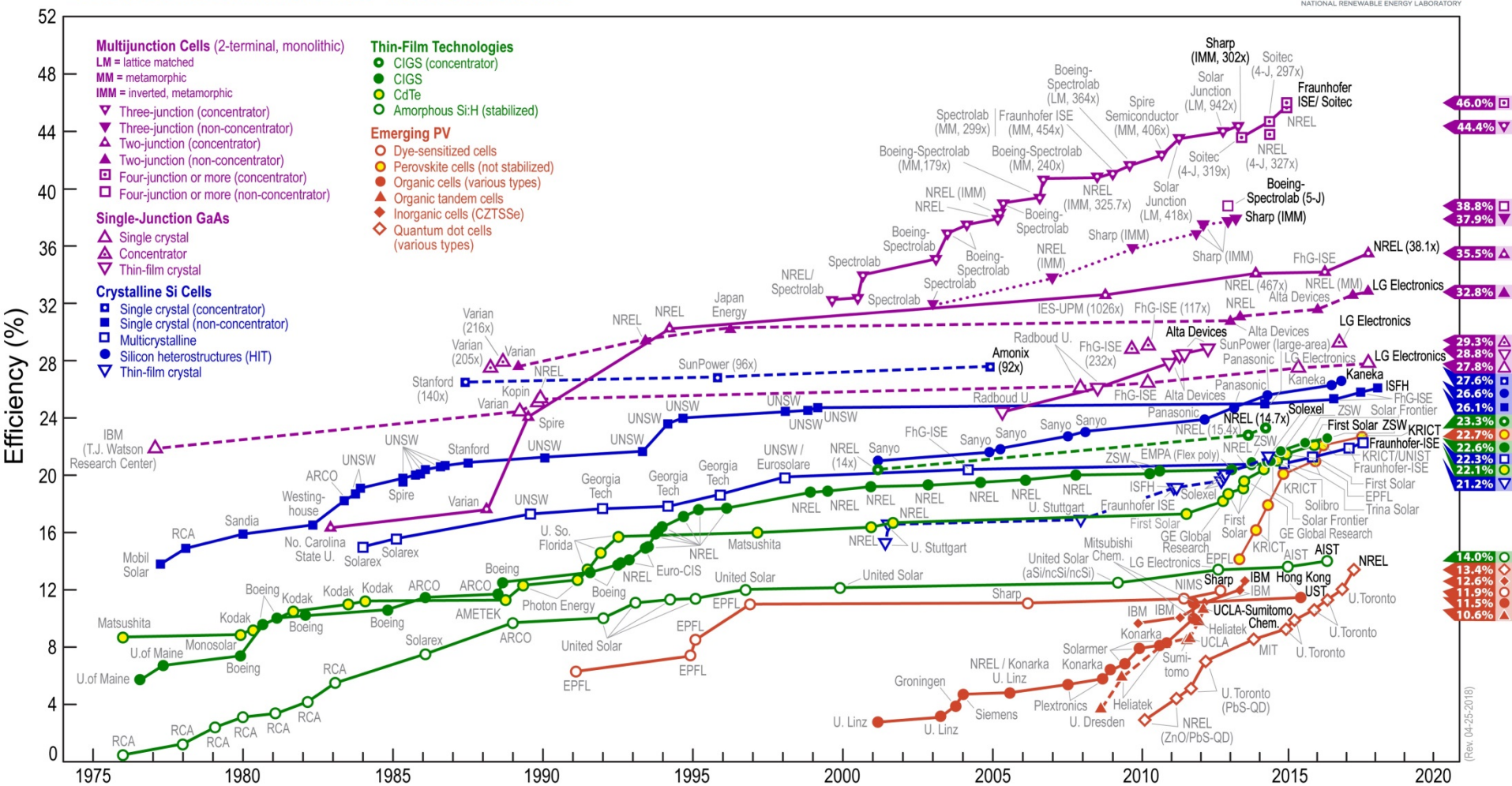


Introduction

- A **solar cell, or photovoltaic cell**, is an electrical device that converts the energy of light directly into electricity by the **photovoltaic effect**.
- A solar cell is a **p-n junction device** with no voltage directly applied across the junction



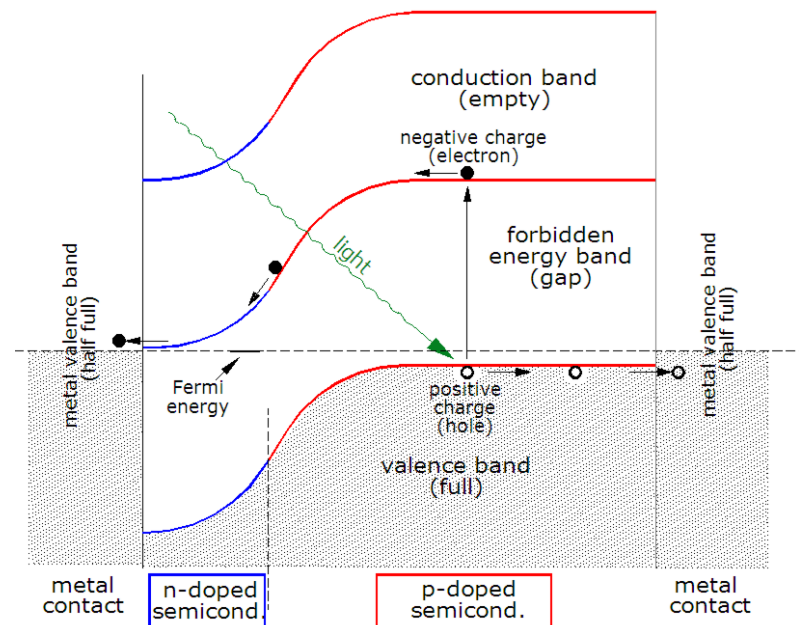
Best Research-Cell Efficiencies



Theoretical background

- The basis for the solar cell is the photovoltaic effect
 - $h\nu > E_g$
 - Because of V_{bi} , it will induce photon current
 - Voltage is formed (across the pn junction)

Group	Material	Symbol	Band gap (eV) @ 302K
IV	Diamond	C	5.5
IV	Silicon	Si	1.11
IV	Germanium	Ge	0.67
III-V	Gallium(III) nitride	GaN	3.4
III-V	Gallium(III) phosphide	GaP	2.26
III-V	Gallium(III) arsenide	GaAs	1.43
IV-V	Silicon nitride	Si ₃ N ₄	5
IV-VI	Lead(II) sulfide	PbS	0.37
IV-VI	Silicon dioxide	SiO ₂	9
	Copper(I) oxide	Cu ₂ O	2.1



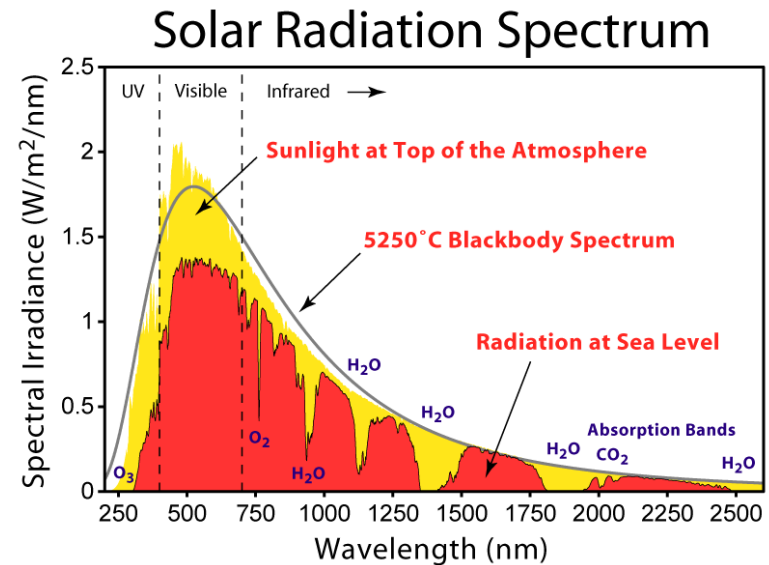
Introduction

- **Silicon (矽)** has the advantages of

- Higher transfer efficiency
- Stability
- Wide spectra range
- Endure higher temperature

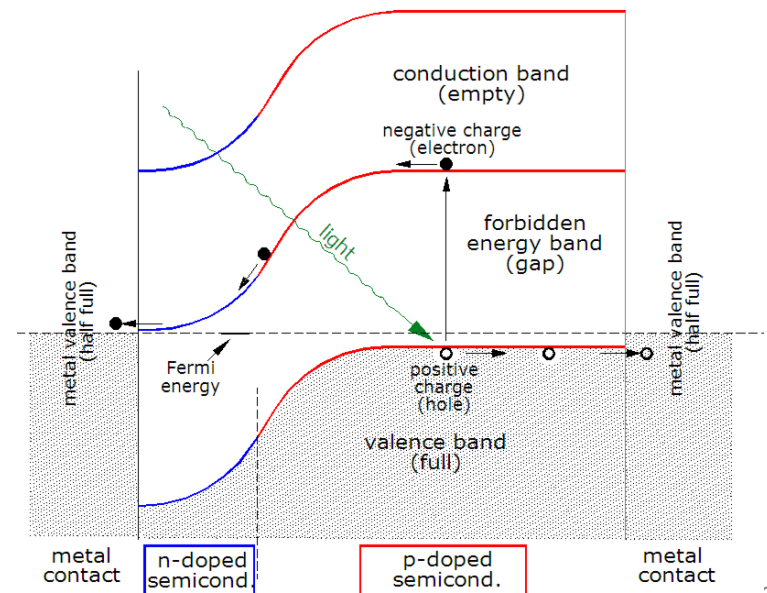
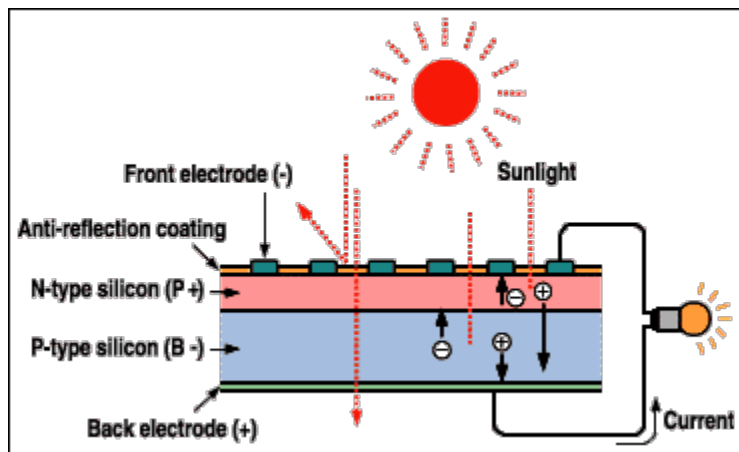
- **Characteristics of Spectra**

- The peak value is dependent on **different materials**
- Si => peak at 850nm(450nm~1100nm)
- Se => peak at 540nm
(visible light with higher sensitivity)



Theoretical background

- There are three reasons why a photon will not create a carrier
 - If the photon energy is **below the band-gap**
 - If the absorption event occurs too far away from the pn junction, the minority carrier **will recombine** before it gets collected.
 - Photon may be reflected from the surface without event entering the semiconductor



The I-V curve of Solar cell

- Power conversion efficiency

- Two limiting cases:

- Short-circuit current

- I_{sc}

- Open-circuit voltage

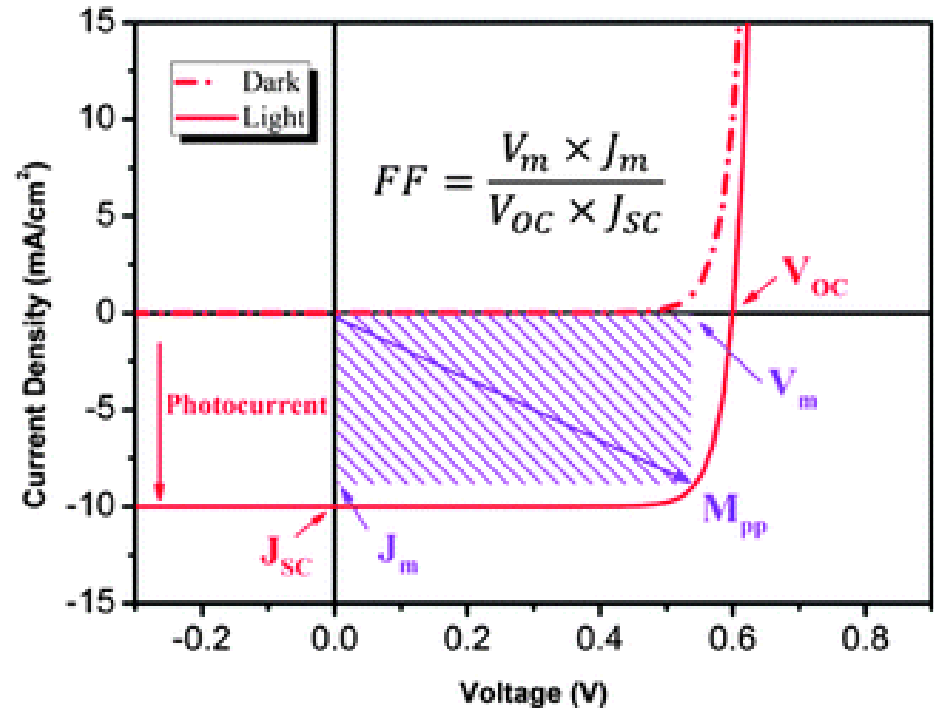
- V_{oc}

- Power conversion efficiency:

$$\eta = \frac{P_{\max}}{P_{in}} \times 100\% = \frac{I_{\max} V_{\max}}{P_{in}} \times 100\%$$

$$= \frac{I_{sc} V_{oc} FF}{P_{in}} \times 100\%$$

$$F.F. = \frac{I_{\max} V_{\max}}{I_{sc} V_{oc}}$$



The equivalent circuit of Solar cell

- Under the **non-idea** situation (with resistance R_{sh} , R_s)

$$I_{pv} = I_L - I_{leak} - I_D$$

I_L : the current with illumination

$$I_{leak} = \frac{V_{pv} + I_{pv} R_s}{R_{sh}}$$

$$I_D = I_S \left[e^{q(V_{pv} + I_{pv} R_s)/nKT} - 1 \right]$$

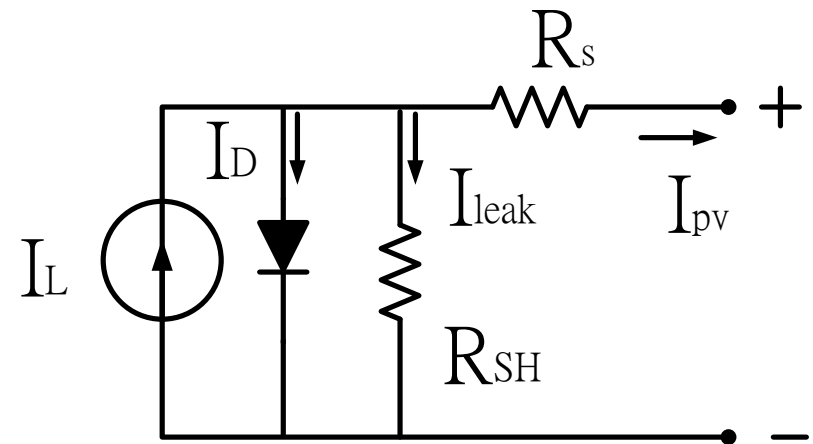
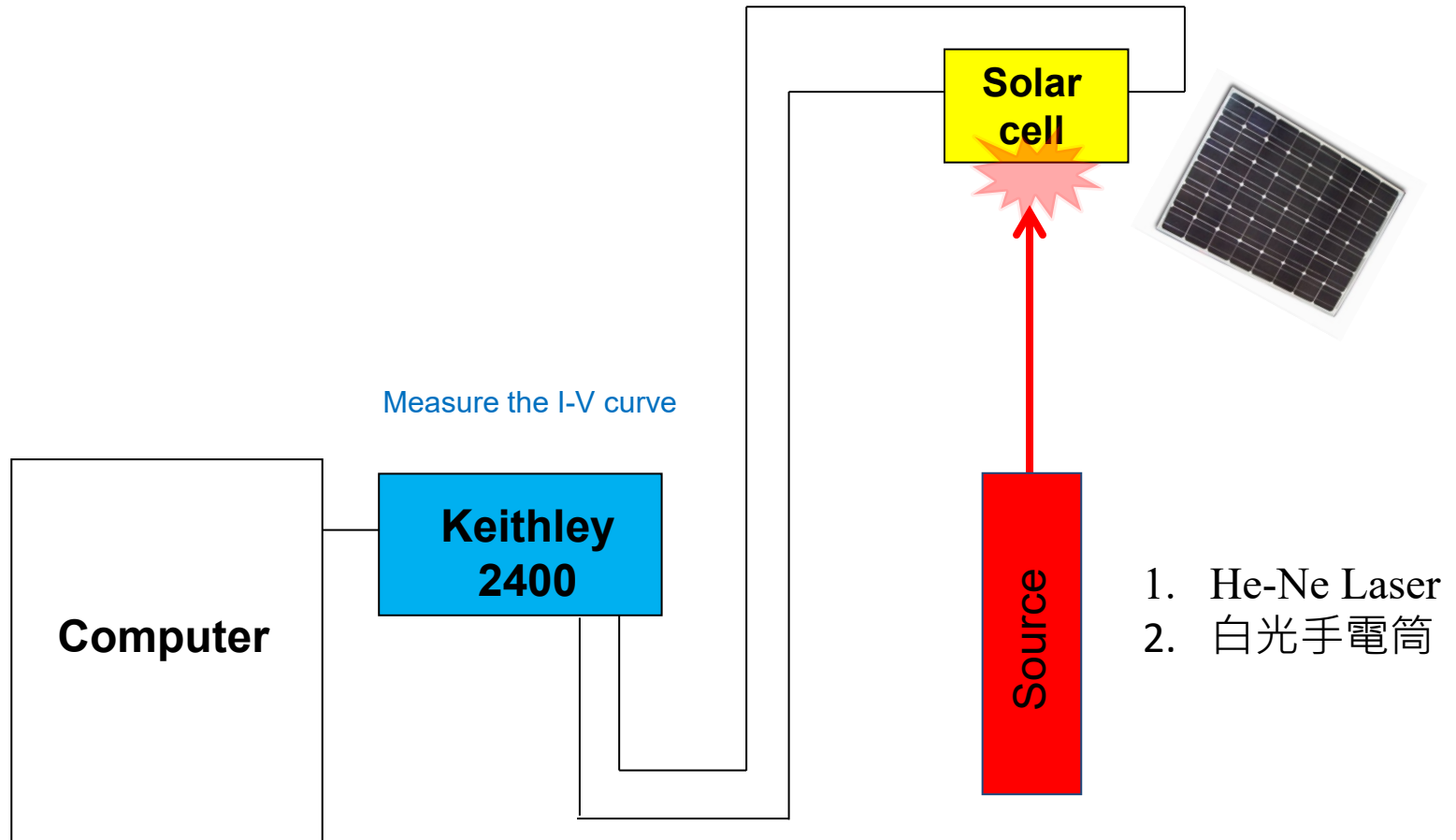


Fig (1) Equivalent circuit of Solar cell

- Complete formula of current of equivalent circuit of Solar cell

$$I_{pv} = I_L - \frac{V_{pv} + I_{pv} R_s}{R_{sh}} - I_S \left[e^{q(V_{pv} + I_{pv} R_s)/nKT} - 1 \right]$$

Experimental setup



預報問題

- What is the external/internal quantum efficiency ?
(請解釋物理意義)
- 請畫出太陽能電池元件的PN型接面能階示意圖？
(各層標註清楚)
- 請舉出一種新穎的太陽能電池材料 (非矽).

