COMPARING PV-CELLS - 50'

Photo-Voltaic (PV) cells have now reached the third generation and talking about the fourth one has already started. Besides improved efficiency and affordability, some of the most innovative PV cells have new and exciting characteristics like being portable, flexible and paper thin, they harvest at low levels of illumination, they show only a slight dependence of the output on the projected shadows (chimney effect) and on the light incidence angle. Such properties make them eligible for "indoor photovoltaic", buildings' facades and windows, wearable applications …

On the desk you have: a plexiglass panel with a few PV cells of different type and size + a lamp with some different kinds of bulbs to use.

We want to compare the efficiency in energy production of the different kinds of PV cell in different light conditions. To do this:

a. You have first to measure the ***short circuit current*** (i_{sc}) and the ***open circuit*** (maximum) ***tension*** (V_{oc}) of the cell; multiplying them you get the (theoretical maximum) ***Power*** produced by the cell: $\mathbf{P=i_{sc}V_{oc}}$
[*To measure i_{sc} and V_{oc} you have to connect the cell to the multimeter: when you set the multimeter position to V, you are measuring the tension in the open circuit composed only by the cell itself; when you turn the multimeter to mA you are measuring the current flowing through the multimeter itself, which has an ideal internal null resistance. Remember to change the red plug position and to turn off the multimeter when you are changing from V to mA measurement. Please note that if you measure V in Volt an i in mA (as usual) you will get the Power in **milli**-Watt*].

b. Quite obviously the Power produced by the PV-cell is dependent (proportional) to its surface (S): so to compare them you have to normalize the Power produced to the ***Power for unit of surface*** (actually the surfaces of the PV-cells on the panel are very different). Use ***Normalized Power:*** **NP = P/S**. (W/m^2)

c. Now let's take one of the PV-cells as a reference [*which one is not important: BUT use the one indicated with "REF" on the panel. This will help comparison between different groups*] and relate the NP of the others to this one (in percent): $\mathbf{NP_{\%} = NP/NP_{ref}\ X\ 100}$. With these numbers you can easily compare the efficiency in energy production of the different kinds of cell and observe how this changes (if it changes !) in different illumination.

NOTE - In each measurement:

- Write down the type and power of the bulb you are using;
- Keep always the same fixed distance between lamp and cell.

Q1. What's the most efficient cell?

In the first measurement you will use an halogen bulb, which is the one whose light is more similar to solar spectrum. Take measures and fill Table1 in the answer sheet.

Q2. Does the efficiency depend on the light source? Motivate your answer on data collected.

Repeat measures changing the bulb; fill the tables n.2. Use the bulb that have been given to your group. Different kinds of bulbs we are going to test are:

- LED bulb
- UV bulb
- IR bulb, both "red-light" bulb and "ceramic" (no visible light) ones

CAUTION! IR ceramic lamp get VERY HOT and it's not immediately visible when they are on!

Q3.Which cells are harvesting in the UV? And which in the IR? And which with LED bulb?

Use the results you got in previous measurement.

Q4. Which cells are less affected by a projected shadow?

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Cover (approximately) ¼ of the surface of each cell with a black cardboard and repeat the measures: fill table n. 3.

Q5. Which cells are less dependent on the tilt angle?
Change the angle of incidence of light onto the cell from (almost) vertical to almost "horizontal" and repeat the measures; fill table n.4.

Q6. Considering your answers to the previous questions and the qualities mostly required for PV cells in the different applications, which of the cells in the panel do you think would work best for indoor harvesting? Why? Which kind of cells would be best to use on facades? Why?

☞ **OUTPUT WANTED:**

->Answer to Q1 ... Q6
->Data Filled Table1 ... Table4
-> At least 2 photos of the experimental apparatus

Suggestions:

- *first fill in the following table measuring the dimension of the cells once for all;*
- *pay attention to the correct use of measurement units;*
- *use scientific notation if you can (NOT numbers with a lot of zeroes!!).*

TABLE n.0	**Quantity:**	**Base: b**	**Height: h**	**Surface (S) = b x h**	
Kind of Cell:	Unit:	**cm**	**cm**	**cm^2**	**m^2**
[Reference]					

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Answer sheet **GROUP N°_____**

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TABLE n. 1	**Quantity:**	**I_{sc}**	**V_{oc}**	**$P=I_{sc} \times V_{oc}$**	**Surf. (S)**	**PN=P/S**	**$PN_{\%} = PN/PN_{Ref} \times 100$**
Kind of Cell:	Unit:						
[Reference]							100 %
Kind and Power of bulb used:							

TABLE n. 2	**Quantity:**	**I_{sc}**	**V_{oc}**	**$P=I_{sc} \times V_{oc}$**	**Surf. (S)**	**PN=P/S**	**$PN_{\%} = PN/PN_{Ref} \times 100$**
Kind of Cell:	Unit:						
[Reference]							100 %
Kind and Power of bulb used:							

TABLE n. 3	**Quantity:**	**I_{sc}**	**V_{oc}**	**$P=I_{sc} \times V_{oc}$**	**Surf. (S)**	**PN=P/S**	**$PN_{\%} = PN/PN_{Ref} \times 100$**
Kind of Cell:	Unit:						
[Reference]							100 %
Kind and Power of bulb used:							

TABLE n. 4	**Quantity:**	**I_{sc}**	**V_{oc}**	**$P=I_{sc} \times V_{oc}$**	**Surf. (S)**	**PN=P/S**	**$PN_{\%} = PN/PN_{Ref} \times 100$**
Kind of Cell:	Unit:						
[Reference]							100 %
Kind and Power of bulb used:							

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Answer sheet **GROUP N°_____**

COMPARING PV-CELLS

Q1

Q2

Q3

Q4

Q5

Q6

PICTURES [***Sent by Whatsapp to your group – See general instruction to share pictures or files***]

- **Pictures description:**

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