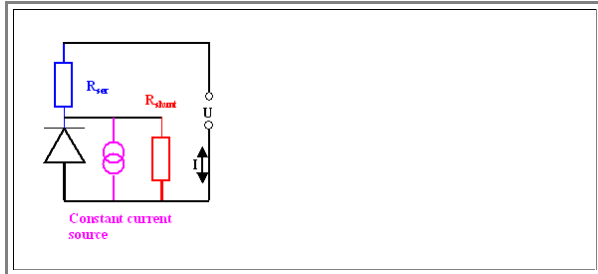


## Exercise 3.4.1

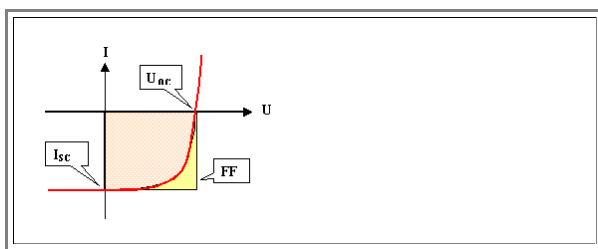
Lets consider a solar cell as an ideal **pn-junction**, for simplicities sake even *without* the current contributions from the space charge region, but *with* a built in **series resistance**  $R_{ser}$  and a **shunt resistance**  $R_{shunt}$

- We have the following equivalent circuit diagram (also defining what is meant by a shunt resistance). See also the "[Solar Cell Primer](#)" in a basic module



- The shunt resistance takes into account that the huge area of the **pn-junction** of a solar cell might have weak points (locally, e.g. at the edge) which short-circuit the junction somewhat. These defects are summarily described by a *shunt resistor*.
- The constant current source mimics the current generated in the junction by light. it simply defines a current value  $I_{phot}$  (not to be mixed up with the terminal current  $I$ ) that is given by the light and added (with a negative sign) to the junction current, i.e.  $I_{junct} = I_{diode}(U) - I_{phot}$ .  $I_{phot}$  thus simply moves the total characteristics of the diode downwards on the current scale.

- Take the following schematic curve of **I-U**-characteristics as a reference and for the definition of the following terms



- The fill factor is the relation between the area of the yellow rectangle to the pinkish area under the characteristics.

Derive the complete current-voltage relationship.

Discuss qualitatively the influence of the two resistors with particular respect to:

- The open-circuit voltage  $U_{oc}$
- the short-circuit current  $I_{sc}$
- The fill factor **FF** (the degree of "rectangularism" of the characteristics).
- The efficiency  $\eta$  which is proportional to  $U_{oc}$ ,  $I_{sc}$ , and **FF**, i.e.

$$\eta = \text{const} \cdot U_{oc} \cdot I_{sc} \cdot FF$$

Link to several exercises to solar cells, far exceeding this one, with the [solutions](#).

There, look at chapter 8.