University of Amsterdam - Universidade do Algarve (Centro de Electrónica, Opto-electrónica e Telecomunicações) - Ioffe Institute

PRESS RELEASE

Contact: Prof. Peter Stallinga
University of The Algarve,
FCT/DEEI, CEOT
Campus de Gambelas, Faro
e-mail: pjotr@ualg.pt

FOR IMMEDIATE RELEASE

BREAKTHROUGH IN SOLAR CELLS

Efficiency improvement of up to 50% expected

One of the major challenges faced by modern society is its energy problem. Fossil fuel burning, as we all know, is the main source for the green house gasses causing Global Warming. The European Union, including Portugal, has committed itself to reduce the amount of CO2 emission by the Kyoto Protocol and recently the Bali Protocol. As of yet, there are no commercially viable alternatives to fossil fuels. Only solar cells are deemed a possible candidate. For that, however, the solar cells have to increase in efficiency to make them competitive with conventional energy sources.

In a research performed by researchers from The Netherlands, Portugal (University of The Algarve) and Russia, in devices based on silicon nano-crystals, a new phenomenon was observed that could pave the way to a significant increase in efficiency of solar cells.

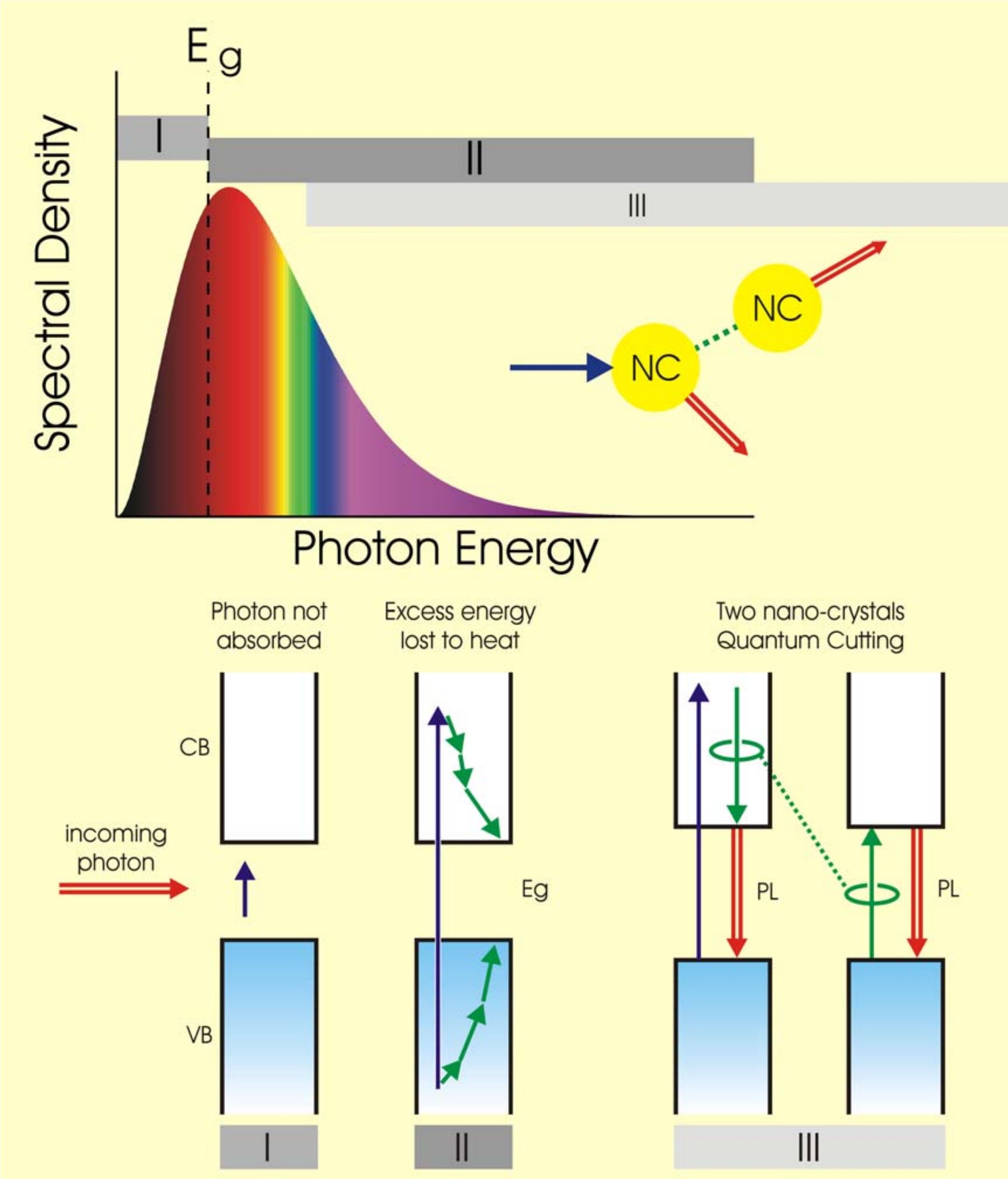
In solar cells normally a substantial percentage of the energy is wasted because on both sides of the energy spectrum the efficiency is limited. Small-energy photons emitted by the sun are not absorbed by the solar cells because their energy is too small (compared to the bandgap E_g of the semiconductor), whereas the excess energy of high-energetic photons is converted into heat rather than electricity. The picture on the next page demonstrates this idea.

Thus, there exists an optimum of energy conversion that is about 30% (70% of the incoming energy wasted), the Shockley-Queisser Limit (SQL). In the research, large energy photons were converted into several smaller energy photons thereby circumventing the SQL and opening a route to more efficiently produce electricity and lowering the cost-per-watt. Theoretically, in this way, the efficiency can be increased from 30% to 45%. An additional interesting feature is that the low-energy emitted photons do not come from the same point in space where the high energy one was absorbed.

The results are already attracting large attention. They will appear in the February issue of Nature Photonics, with an accompanying Interview of the research leader (Prof. Tom Gregorkiewicz of the University of Amsterdam) and a “Highlight” in Nature.

# # #

If you’d like more information about this topic, please contact P.S. through pjotr@ualg.pt at the University of The Algarve (FCT/DEEI).

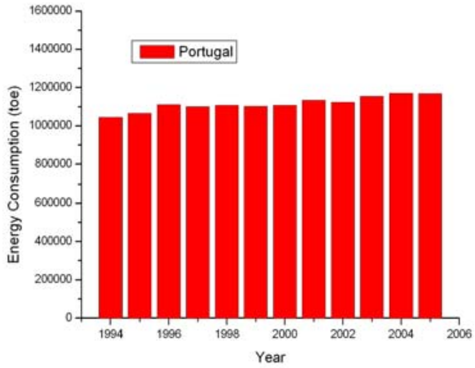


Top: solar spectrum from infrared (left) to ultraviolet (right)
Bottom: Energetic diagrams of nano-crystals showing the processes: photon absorption, charge-carrier cooling, energy transfer and photon emission (PL).

I: Incoming (infrared) photon with energy too small to be absorbed by the solar cell.
II: High energy (UV) photon absorbed by solar cell, but excess energy (> Eg) converted into heat rather than electricity.
III: Observed scheme: Cutting a high-energy photon into two smaller-energy photons (with the use of two neighboring silicon nano-crystals) that can henceforth be used for more efficient conversion to electricity.

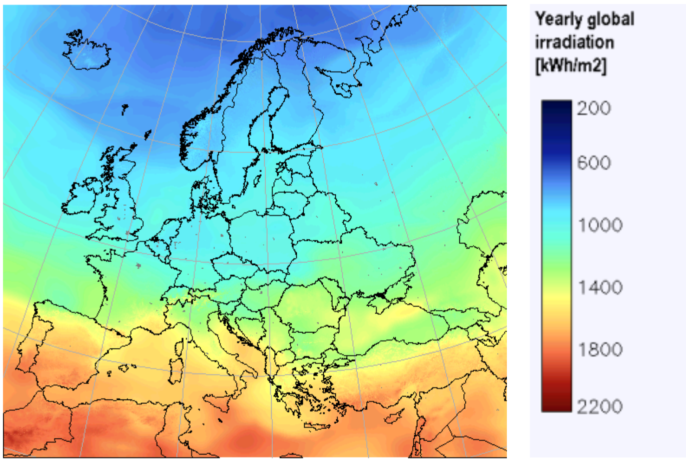
Additional Information

The figure below shows the evolution of the energy consumption of Portugal until 2005 in units toe per year (toe = ton of oil equivalent, 1 toe = 41.868 GJ, 1 GJ = 1000,000,000 Joule). Source: Eurostat.



The next image shows the solar radiation map of Europe showing how (the South of) Portugal is the ideal place for solar power plants, with an average radiation of 1800 kWh per year per m^2. 1 kWh = 3,600,000 J). Source:

http://re.jrc.ec.europa.eu/pvgis/imaps/index.htm.



Combining the two maps and assuming an efficiency of energy conversion of 10% (Scientific American January 2008), an area of about 1.2 x 10^9 m^2 (35 km x 35 km) is needed to supply the entire energy of Portugal, see the red square indicated on the map. It is obvious that any increase in efficiency of the solar cells has a direct impact on society.