Ultrathin solar cells, towards a cheaper solar energy

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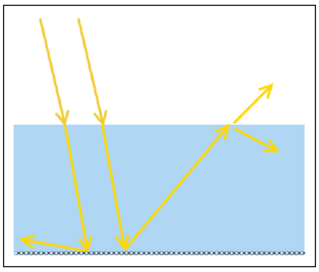
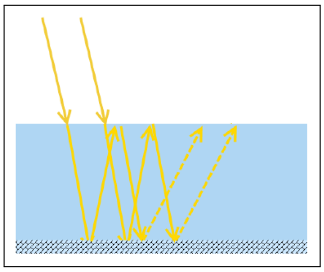
Reducing the solar cells thickness is a step forward towards cheap, highly efficient photovoltaic modules. In this project, an innovative light-trapping strategy has been adapted and developed, which shows promising simulation results.



(a) *Random reflection of light.*



(b) *Coupling to resonant modes, enhanced absorption.*

In one minute the Earth's surface receives more power from the sun than all humans alive consume in one year. Based on this observation, photovoltaic solar cells have the potential to be a major source of green electricity for humanity. Of course, it comes with some drawbacks. The first one is its volatility, because solar power is not available at all times, and the production is imposed by the weather and the time of the day. This can be addressed with the development of better electricity management solutions like storage or smart-grids. The second major issue is that the price per watt of solar cells is still too high to make traditional energy sources uncompetitive.

Efficiency : The efficiency of a solar cell is the ratio of the electricity power delivered by the device to the light power that it receives from the sun.

It is this point that this project contributes to address since we propose to make an ultrathin solar cell. The core of this solar cell, which absorbs the light, will be about 10 times thinner than the ones of the most efficient solar cells produced today. As a direct consequence, the expensive material amount is also reduced by tenfold, and the price of the cell will drop. Of course, the efficiency of such a cell must remain quite good to improve the overall efficiency/price ratio.

But there is a major issue with ultrathin cells : the light is harder to absorb, as it will pass through the thin layers and escape at the back or after one reflexion. A solution is to 'trap' it inside of the solar cell, using resonance effects, such as in Figure b. This project has focused on implementing a mirror with nano-structures that will activate many resonant phenomena which can effectively trap the light inside the cell. It basically comes back to having a thick light absorber with a very thin layer of relatively expensive material. The numerical simulations have shown that this structure can reach efficiencies close to 21 %. the best efficiency in the world for those types of solar cells is 28.4%, but with 5 times more material!

Besides the saving of material, this project also paves the way towards 3rd generation solar cells, which will rely on even less material, e.g. nanowire solar cells. The problematic of light trapping with very few material is also a key issue for those future cells.