Three for the price of one -- mobile electrons multiplied in quantum dot films

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Researchers of the Opto-electronic Materials section of Delft University of Technology in the Netherlands and Toyota Europe have demonstrated that several mobile electrons can be produced by the absorption of a single light particle in films of coupled quantum dots. These multiple electrons can be harvested in solar cells with increased efficiency. The researchers published their findings in the October issue of the scientific journal *Nano Letters*.

A way to increase the efficiency of cheap solar cells is the use of semiconductor nanoparticles, also called quantum dots. In theory, the efficiency of these cells can be increased to 44%. This is due to an interesting effect that efficiently happens in these nanoparticles: carrier multiplication. In the current solar cells, an absorbed light particle can only excite one electron, while in a quantum dot solar cell a light particle can excite several electrons. Multiplying the number of electrons results in the enhancement of current in solar cells, increasing the overall power conversion efficiency.

Carrier Multiplication

Several years ago it was demonstrated that carrier multiplication is more efficient in quantum dots than in traditional semiconductors. As a result, these quantum dots are currently heavily investigated worldwide for use in solar cells. A problem with using carrier multiplication is that the produced charges live only a very short time (around 0.00000000005 s)

before they collide with each other and disappear via a decay process known as Auger recombination. The main current challenge is to proof that it is still possible to do something useful with them.

Mobile charges

The researchers from Delft have now demonstrated that even this very short time is long enough to separate the multiple electrons from each other. They prepared films of quantum dots in which the electrons can move so efficiently between the quantum dots that they become free and mobile before the time it takes to disappear via Auger recombination. In these films up to 3.5 free electrons are created per absorbed light particle. In this way, these electrons do not only survive, they are able to move freely through the material to be available for collection in a solar cell.

Provided by Delft University of Technology