Plastic Solar Cell Technology

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Abstract

Solar cells use freely available sunlight to make electricity. At the present time, solar electricity does not come cheap, because solar panels are rather expensive. Now imagine that we could reduce costs by printing solar panels like we print newspapers! We can do just that with plastic solar cells. In this article, we explain the basic working principles of these novel plastic solar cells and then show how a stunning threefold increase in solar energy efficiency can be achieved by including a special additive to the printing ink. The function of such a special additive seems almost magical, but as scientists we know that true magic is really rare and we simply had to find out why and how it works. That was the subject of our recent investigations and in this article we describe how we divulged the secret of the special additive.

Introduction

- Plastic solar cells, based on blends of conducting organic polymers, are of interest for making lightweight and cheap solar cells.
- The problem with the solar cells is that their solar power efficiencies are very closely related to the way the different types of materials mix and crystalize in thin films.
- Organic solar cells work based on light energy exciting electrons in a polymer. The excited electrons can then transfer to a soccer ball-shaped fullerene and move to the positive side of the solar cell.
- The space left by an electron is known as a hole. It too must move through the polymer to the other side of the device to complete the circuit.

Figure 1: A Solar cell [3]

HOW DO PLASTIC SOLAR CELLS CHANGE LIGHT INTO ELECTRICITY?

- Plastic solar cells consist of a plastic layer on glass or a flexible foil.
- In the lab, we use glass plates with a transparent electric contact [the positive (+) pole]. On top of this contact, we put the ink for the active layer the most important layer of plastic solar cells.
- This layer is where sunlight is converted into charge, which is the part of the solar cell that converts sunlight to electricity. This ink contains two polymers, a long green one and a shorter red one. The polymers form a mixed layer, as shown in Figure.
- On top of that layer, we put a metal layer, which functions as the negative pole. We then turn the whole stack of layers upside down such that sunlight can shine through the glass into the active layer.

CAN WE SEE THESE SMALL POLYMERS?

- A normal microscope uses light to see very small things. However, if things are too small to see with a normal microscope, we need to use an electron microscope. As the name implies, electrons are used instead of light, which does not use light, but electrons to look at the solar cells.
- The two polymers show up as dark and bright areas and not as red and green because electrons are colorblind. A poorly working plastic solar cell is shown.

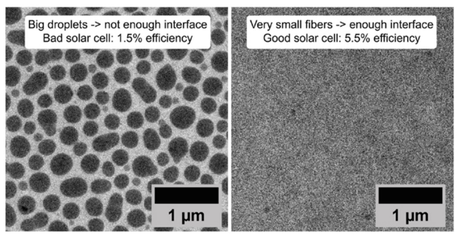
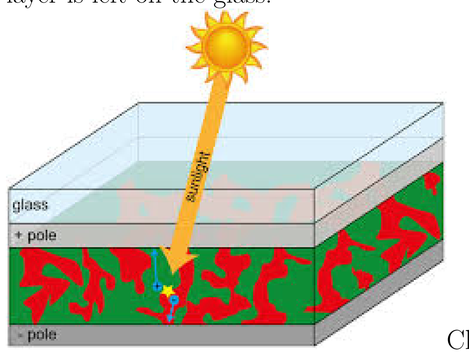


Figure 2: Microscopic view [1]

THE SPECIAL ADDITIVE

- The additive is a slowly drying liquid, which is added to the ink in a small amount. This smart trick was first shown in 2007 [4], but nobody understood exactly how it works.
- The active layers are made by a process called spin coating A coating method to make very thin films. A droplet of ink is put on a glass slide, which is then rotated at high speed to spread the ink. After spreading, the ink dries and a very thin layer is left on the glass.



Change of light into electricity [2]

A NEW EXPERIMENTAL SETUP SOLVED THE MYSTERY

- To study this drying process during the spin coating process, we had to build a new experimental setup. In this setup, we shine a laser on the spinning glass plate. The reflection of the laser changes when the droplets are formed.
- In this way, we found that without additive the large droplets form in a late stage of the drying process, and even later, the green polymer changes color! To understand what happens when the color changes, we recall that the green component is a long polymer.
- We know that long polymers can fold up, similar to how a snake curls up. The folding makes the green polymers change their color to dark green.

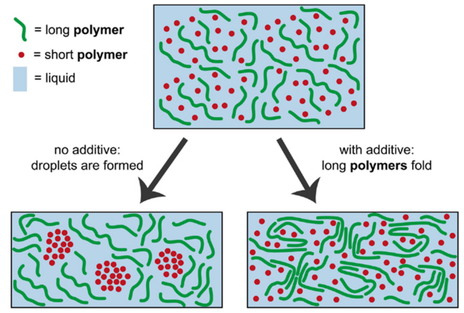


Figure 3: Results [3]

Conclusion

- Plastic solar cells have a huge potential because they can be printed cheaply on large flexible foils. Their efficiency still needs improvement, but can be improved threefold by adding a special additive to the printer ink.
- Since this additive is very useful, we wanted to understand how it works. With a new experimental setup designed to study the drying of the ink, we found that the special additive controls folding of one of the two polymers. The folding prevents large droplets and increases the amount of interface between the two polymers in the active layer.
- The interface is very important the efficient conversion of sunlight into electricity. Now, because we understand the process of the drying, we can think of even more clever tricks to optimize these solar cells! In the future, this will hopefully lead to cheap and efficient electricity production from printed solar panels!

References

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