Karlsruhe Institute of Technology

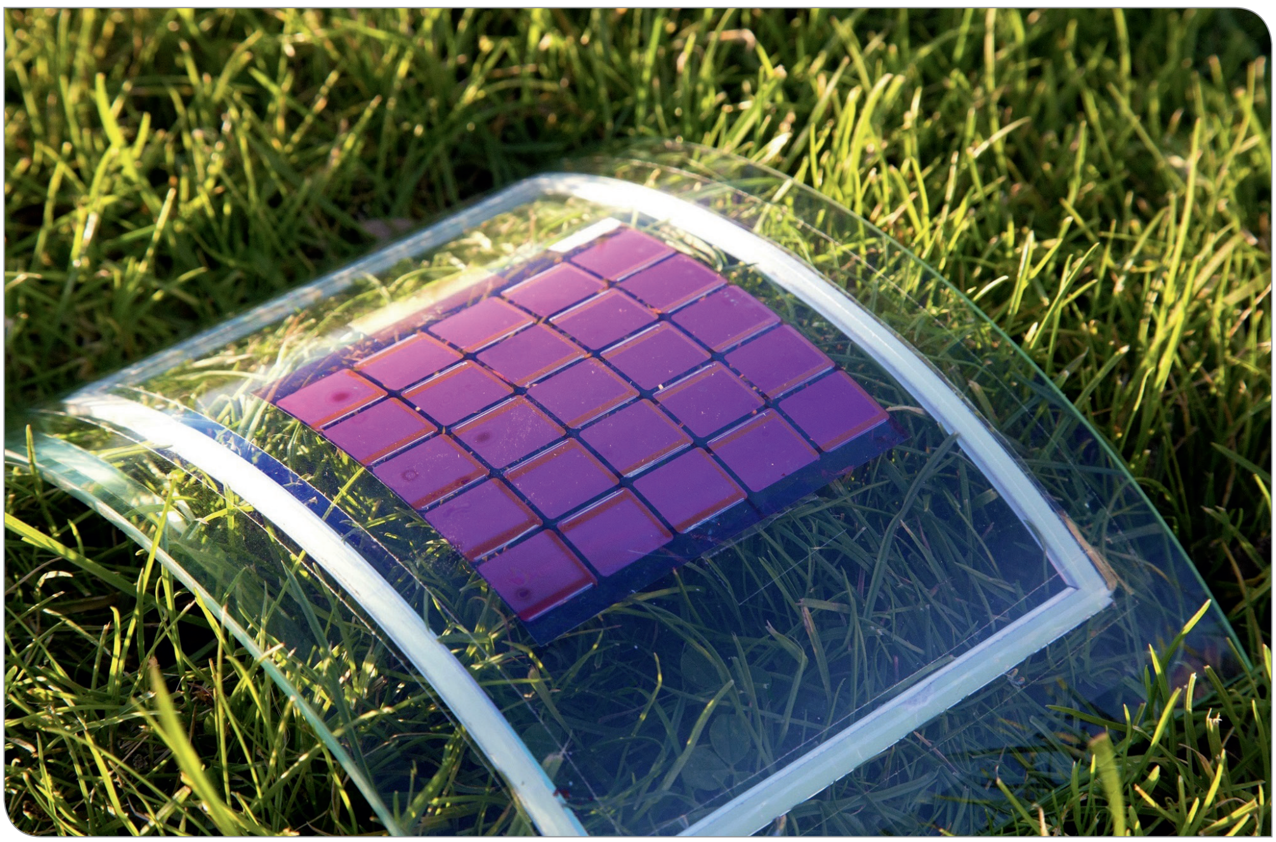
Division III – Mechanical and Electrical Engineering

Light Technology Institute

Organic Photovoltaics

Organic solar cells differ visually from common silicon solar modules. They can be deposited on plastic sheets and, hence, are of low weight and mechanically flexible. Due to the large number of organic semiconducting materials available, organic solar cells can be fabricated in almost any color or even semi-transparently. With these unique properties, new fields of application which cannot be covered by conventional photovoltaic technologies are opened up. Organic solar cells can be adapted to a wide range of applications, from mobile uses like a rollable cell phone charger to facade window integration.

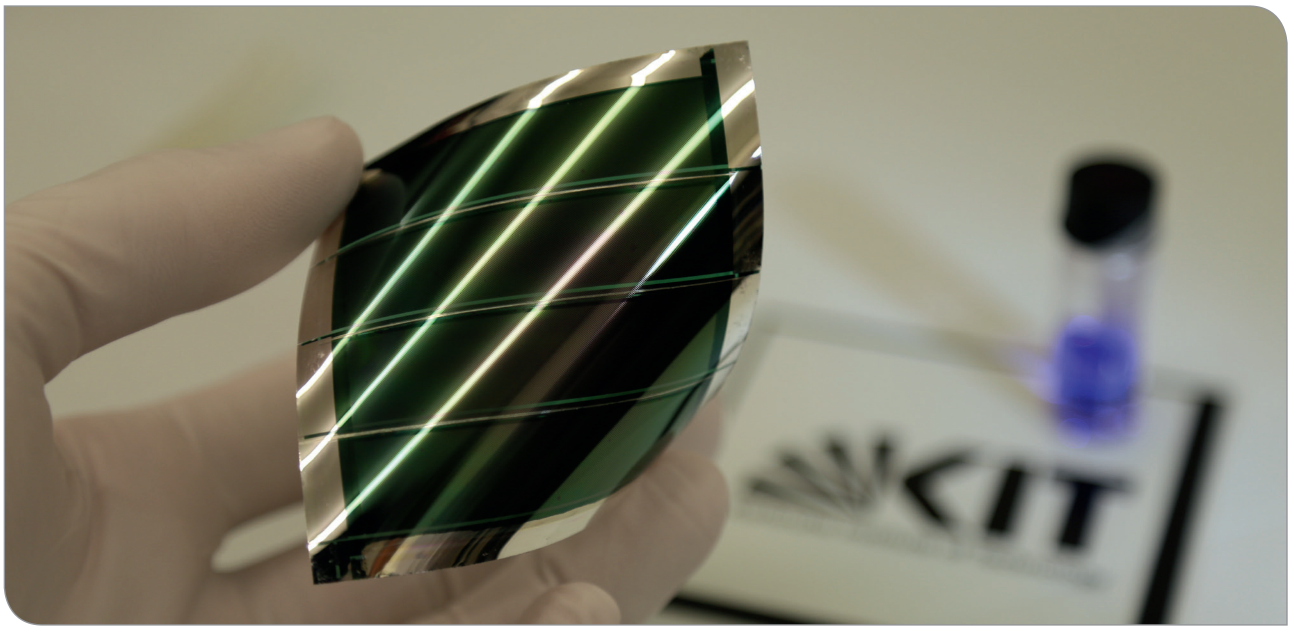
Like silicon photovoltaics, organic solar cells convert incident sun light into electrical power. But in contrast to conventional technologies, organic semiconductors are employed. The excitation of charge carriers is based on the internal photoelectric effect as in every solar cell. But charge carrier dissociation works differently. In silicon photovoltaics, the charge carriers are only weakly bound to each other. They can be separated easily by the internal electrical field caused by differently doped layers in the solar cell and can be conducted to the electrodes. In organic semiconductors, the excited charge carriers are much more strongly bound and additional energy is needed to separate them. This energy can be gained when transferring the charge carriers to a different material. That is why the absorber layer in organic photovoltaics consists of a blend of at least two different materials or of a double layer. Additionally, the internal



Environmentally friendly production of organic solar cells. (Photo: Alexander Colsmann, LTI) electrical field in organic solar cells usually does not result from doped layers. It is generated by electrode materials with different work functions.

Organic solar cells have not caught up with silicon photovoltaics so far in terms of performance. They exhibit lower power conversion efficiencies as well as shorter lifetimes. But their environmental impact is considerably better. Since the purification of solar-grade silicon requires an immense amount of energy, it takes at least one and a half years until the applied energy and the emitted carbon can be regained by the solar cell. During the fabrication of organic solar cells, no high process temperatures are needed. Consequently, the energy and carbon payback time is reduced to some weeks only. Furthermore, KIT developed a method for depositing organic semiconductor layers without the use of halogenated or toxic solvents. For this research on organic solar cells from nanoparticle dispersions , scientists from KIT were awarded the Gips-Schüle Research Award in 2015.
www.gips-schuele-stiftung.de

Nowadays, hundreds of organic semiconductors suitable for solar applications are available. Besides color, they also differ in their electrical properties. Hence, it is possible to choose the right material for every possible application. Processing from solutions or dispersions is well-developed and allows for the use of conventional coating and printing techniques for fabrication of organic solar cells. Hence, there is no practical limit for designing their appearance in terms of color and shape.



Light, flexible, and environmentally compatible: The novel organic solar cells have many advantages over conventional solar cells. (Photo: Lorenz Graf von Reventlow)

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