

CNT-PV

Carbon nanotube hole-transporting and collecting layers for semi-transparent, flexible and low-cost solid-state photovoltaic cells

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Publishable Summary

The perovskite solar cell (PSC) and the quantum dot solar cell (QSC) are emerging solar cell technologies, whose manufacturing costs and energy payback times could be considerably lower than those of silicon solar cells that dominate the photovoltaics (PV) market today. Other interesting properties of the PSCs and QSCs are for instance semi-transparency, flexibility, color and light weight – properties that can be utilized for instance in building-integrated PV products and indoor and outdoor consumer PV products.

While more than 20 % power conversion efficiency has been obtained for PSC, commercialization PSC is hindered by the use of unstable and expensive hole-transporting materials (HTM) deposited by the industrially non-viable spin-coating technique and silver or gold counter electrodes (CE) deposited by a vacuum technology.

In this project we have explored press-transferred, semi-transparent, extremely flexible single-walled carbon nanotube (SWCNT) films that function as a hybrid hole-transporting and collecting layer in the PSC. The expensive HTM material and silver or gold contacts can be omitted completely. We achieved 16 % power conversion efficiency that was obtained for PSC with SWCNT contact with a small amount of drop-cast molecular HTM. Importantly, the stability of the devices was dramatically improved compared to those with spiro-OMeTAD /Au contacts. Extremely transparent (T = 70 %) SWCNT films function well as the front contacts for PSC and QSC. Furthermore, we demonstrated flexible PSC and QSC devices.

Simultaneously, processes for the gas-phase formation of SWCNT were optimized and scaled-up. Alternative carbon sources (ethene, ethanol) were successfully tested. Doping procedures were developed to achieve n-type doping, besides the more common p-type doping. In practical devices, however, C60 rather than SWCNT performed better as a carbon based n-type contact.

Project consortium

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Participating countries and financing:

Country	Number of organisations involved	Project costs in EUR	Public funding in EUR
Sweden	2	390'000	100'000
Finland	2	330'000	119'000
<i>Total</i>	<i>4</i>	<i>720'000</i>	<i>219'000</i>

Funding agencies involved and contracts

Funding Agency	Contract N° and Title
Swedish Energy Agency	42076-1 "Carbon nanotube hole-transporting and collecting layers for semi-transparent, flexible and low-cost solid-state photovoltaic cells"
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Tekes	3303/31/2015 "Carbon nanotube hole-transporting and collecting layers for semi-transparent, flexible and low-cost solid-state photovoltaic cells"
Tekes	3952/31/2015 „Carbon nanotube hole-transporting and collecting layers for semi-transparent, flexible and low-cost solid-state photovoltaic cells“