Aalto University

Dissertation press release 14.05.2020

Rational design transparent conductor in hybrid heterostructure solar cells

Title of the dissertation	Hybrid heterojunction solar cells using single-walled carbon nanotubes and amorphous silicon thin films
Contents of the dissertation	Most of the daily encountered optical and electronic devices constitute of transparent conductors. However, all the present available transparent conductors are n-type semiconductors, thus restricting technological advancement. The emergence of singe-walled carbon nanotubes (SWCNTs) as p-type transparent conductors has been promising due to its extraordinary optical, electrical, chemical, and mechanical properties. Thin films of randomly oriented SWCNTs have a great potential in many opto-electro-mechanical applications. Moreover, recent developments in photovoltaics have been largely contributed by SWCNTs as a p-type transparent conductor that fulfill the requirements for continuous, fast, and cheap film manufacturing process compatible with the roll-to-roll technology. This dissertation reveals the development of a novel design for p-type transparent conductor using SWCNTs and its application in solar cell based on amorphous silicon. At first, quantitative measurements of the adhesion of SWCNT films with substrate materials is studied for successful implementation of SWCNTs film in solar cells. Later, a simple fabrication method of hybrid heterostructure solar cells is proposed in which the SWCNTs and organic conductive polymer composite p-type film forms a coupled continuous hybrid heterojunction with amorphous silicon absorber. Finally, a rationally designed p-type transparent conductor is developed using a combination of composite SWCNTs film and fibers, which by itself can be used as replacement for traditional metal contacts as demonstrated here. This opens a new avenue in widespread energy technologies, where high hole conductivity and transparency of the material are prerequisites for their successful implementation. At last, integrating the developed p-type transparent conductor in hybrid heterostructure solar cells resulted in a dramatic increase in its power conversion efficiency.
Field of the dissertation	Engineering Physics
Doctoral candidate	Pramod M. Rajanna, M.Sc
Time of the defence	27.05.2020 at 17:00
Place of the defence	The public defense will be organized together with Skolkovo Institute of Science and Technology, Russia via Zoom: https://aalto.zoom.us/j/63096711658
Opponent	Professor Anvar Zakhidov, University of Texas at Dallas, USA
Custos	Professor Peter D. Lund, Aalto University School of Science, Department of Applied Physics
Supervising professors	Professor Peter D. Lund, Aalto University School of Science, Department of Applied Physics Professor Albert Nasibulin, Skolkovo Institute of Science and Technology, Russia
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The doctoral dissertation is conducted under a convention for the joint supervision of thesis at Aalto University (Finland) and Skolkovo Institute of Science and Technology (Russia)