Abstract

Organic photovoltaics (OPVs), being eco-friendly and inexpensive to produce, are considered as the potential sustainable energy source for the future. However, on the way to their commercialization, performance improvements still have to be obtained, especially for large-scale devices, which significantly lack behind their inorganic counterpart. This study addresses these issues, and the results are presented in two sections. The first section focuses on the enhancement of OPV performance by incorporation of interfacial layers in form of exciton blocking and electron transport layers that reduce the exciton recombination and charge carrier losses in the devices.

I report on the implementation of a novel exciton blocking layer of an intrinsic organic material, ‘N,N'-di-1-naphthalenyl-N,N'-diphenyl [1,1':4',1'':4'',1‴-quaterphenyl]-4,4‴-diamine (4P-NPD)’, in organic small molecule-based OPVs. Using this interlayer, the efficiency of OPV devices increased by approx. 24 % compared to reference devices. I also report on the use the use of electron transport layer of organic material ‘2,9-Dimethyl-4,7-diphenyl-1,10-phenanthroline (Bathocuproine, BCP)’ for inverted small molecule-based lab-scale and up-scaled OPVs. The pronounced clustering of the BCP layer lead to increasing discrepancies in the device performance with the increase in the device size, which disqualifies it for use of in the inverted large area OPVs.

The second section deals with up-scaling of highly conductive semi-transparent electrodes for rigid as well as flexible substrates that prevent the resistive losses in the large area OPVs. Here, I report on the newly developed highly conductive semi-transparent electrodes, based on current collecting grids of silver embedded in indium tin oxide (ITO) layers on glass and flexible substrates, which successfully diminish the performance losses in large area OPVs due to the reduced resistance of semi-transparent electrodes.

Resumé

Organisk fotovoltaik (OPV), som er miljøvenlig og billig at fremstille, forventes at være en potential bæredygtig energikilde i fremtiden. På vejen til kommercialisering er det dog tydeligt at forbedringer i deres ydeevne er nødvendigt, specielt for stor skala devices, da disse halter betydeligt efter deres ikke-organiske modstykker. Dette studie fokuserer på dette, hvor resultaterne er præsenteret i to sektioner. Den første sektion fokuserer på forøgelse af OPV nyttevirkningen gennem integration af grænsefladelag i form af exciton blokerende lag og elektron transport lag, som reducerer exciton rekombinationen og ladningsbærertabene i cellerne.

Jeg rapporterer her omkring implementering af nye exciton blokerende lag bestående af det organiske materiale ‘N,N'-di-1-naphthalenyl-N,N'-diphenyl [1,1':4',1'':4'',1‴-quaterphenyl]-4,4‴-diamine (4P-NPD)’ i organiske små molekyle baserede OPV celler. Ved hjælp af dette grænsefladelag øges nyttevirkningen af OPV devices med ca. 24 %, sammenlignet med reference devices. Jeg rapporterer også omkring brugen af elektron transport lag bestående af det organiske materiale ‘2,9-Dimethyl-4,7-diphenyl-1,10-phenanthroline (Bathocuproine, BCP)’ til små molekyle baserede lab skala og opskalerede devices. Den fremtrædende cluster formering i BCP lagene fører til øget afvigelser i device ydeevnen med øget device størrelse, hvilket diskvalificerer laget til brug indenfor inverteret, storskala OPV.

Den anden sektion omhandler opskalering af ledende, gennemsigtige elektroder til rigide såvel som til fleksible substrater, der forebygger modstandstab i storskala OPV. Her rapporterer jeg omkring nyligt udviklet gennemsigtige elektroder med høj ledningsevne baseret på strømledende sølvgitre der er integreret i indium tin oxid (ITO) lag på glas og fleksible substrater, hvilket succesfuldt minimerer ydeevne tab i storskala OPV grundet reduceret modstand i de gennemsigtige elektroder.