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Conjugated Polymer Coating for Nano-Structures: Chemical Vapor Deposition Polymerization for Excitonic Solar Cells

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ABSTRACT

This work presents the thermal chemical vapor deposition polymerization (CVDP) of the conjugated polymers demonstrating that CVDP is quite an effective top-down method to fabricate nano-materials, nano-composites, and conformal coating on nano-structures. It is a great challenge to prepare the pristine form of most conjugated conducting polymers in desired shapes and dimensions because they are mostly insoluble and infusible. This task is often detoured by first synthesizing soluble derivatives of the pristine polymer, dissolving it in solvents, and preparing polymer films via solution-based processes including simple solution casting, spin coating, and screen printing. It is more challenging to make a top-down approach to create polymer nano-structure or conformal polymer coating onto nano-structures like nano-trenches. For example, there have been a number of research activities to realize ordered bulkheterojunction solar cells in the field and the pores of electron acceptor materials are often infiltrated by polymer solution or melted polymer to create the junction. While current technology often depends on the solution methods to fabricate optoelectronic devices including organic light emitting diodes and photovoltaic devices, CVDP can provide a new approach for these applications.

In this study, new thiophene-derivatives conjugated polymers particularly with a low bandgap (< 1.8 eV) will be synthesized by CVDP for photovoltaic application. Most well-known conjugated polymers for solar cells typically have a band-gap over 1.8 eV, which is too high for the optimal terrestrial photovoltaic devices and there is great need for the low bandgap conjugated polymer to increase external quantum efficiency – only 25 % of sunlight can be absorbed by a typical 200 nm thick polymer film with a bandgap of 2 eV. This study, for the first time, targets the deposition of low bandgap conjugated polymers using CVDP particularly for photovoltaic applications. The results show further potential of CVDP proposing a number of new ideas for the future.