3D Amorphous Silicon Carbon Nanotube Based Photovoltaics

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EXTENDED ABSTRACT

In this study, the possibilities of a 3D amorphous silicon (a-Si) based photovoltaic (PV) cell are investigated. Vertically aligned carbon nanotubes provide a significant advantage by allowing more opportunities for light trapping absorption and increasing dwell time in photovoltaic materials, while creating a 3D array. This allows for the use of less and therefore cheaper PV material, particularly a-Si. This study proposes creation of such a novel PV cell through thermal chemical vapor deposition (TCVD), ion assisted deposition (IAD), and plasma-enhanced chemical vapor deposition (PECVD) techniques. This novel 3D a-Si PV cell experiences better absorption and requires thinner layers than its planar counterpart, while encountering an increased short circuit current density and fill factor. The 3D a-Si PV cell consists of a single junction p-i-n photodiode less than 250 nm in total width and absorbs photons just above the 1.7 eV energy level. Combined with the ballistic conductance abilities of carbon nanotubes, the use of thinner layers also leads to the possibility of high performance and inexpensive heterojunction solar cells. Further, the amorphous semiconductive electronic structure of a-Si and its interactions at the CNT interface are explored, as well as the impact of thinner layers on the temperature-efficiency relationship of this unique PV cell.