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Controlling electron recombination in nanowire-based DSSCs

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Electron recombination in dye-sensitized solar cells (DSSCs) results in significant electron loss and performance degradation. To our knowledge, the reduction of electron recombination via blocking layers in nanowire-based DSSCs has never been investigated. In this study, HfO_2 or TiO_2 blocking layers are deposited on nanowire surfaces via atomic layer deposition (ALD) to reduce electron recombination in nanowire-based DSSCs. The control cell consisting of ITO nanowires coated with a porous shell of TiO_2 by $TiCl_4$ treatment yields an efficiency of 2.82%. The efficiency increases dramatically to 5.38% upon the insertion of a 1.3 nm TiO_2 compact layer between the nanowire surface and porous TiO_2 shell. This efficiency enhancement implies that porous sol-gel coatings on nanowires (e.g., via $TiCl_4$ treatment) result in significant electron recombination in nanowire-based DSSCs while compact coatings formed by ALD are more advantageous because of their ability to act as a blocking layer. While the insertion of a high band-gap compact layer of HfO_2 between the interface of the conductive nanowire and TiO_2 shell improves performance, a comparison of the cell performance between TiO_2 and HfO_2 compact layers indicates that charge collection is suppressed by the difference in energy states. Consequently, the use of high band-gap materials at the interface of conductive nanowires and TiO_2 is not recommended.

Biography

Kirk J Ziegler joined the Chemical Engineering Department at the University of Florida in 2005. His research group focuses on understanding the role of interfaces in one-dimensional nanostructures, such as single wall carbon nanotubes (SWCNTs) and vertical arrays of nanowires. His work on SWCNTs has focused on understanding the effect of surfactant-nanotube interactions on dispersion and separation processes. His work on nanowire arrays has applications in energy-related devices, which requires high surface area to maximize energy generation or storage.

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