OAK RIDGE NATIONAL LABORATORY
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Design of coaxial TiO2 nanotube arrays for solar energy utilization

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Technology Summary

The activity in solar cell research has considerably increased due to the need for solar-to-electricity conversion with increased efficiency. Higher efficiency of conversion of light to electricity can be achieved in multi-junction PV cells, which are applicable for thin film and organic cells. The concept takes advantage of several light absorbing materials with different band gap, combining them in a sandwich configuration such that each layer would absorb part of the solar spectrum. Theoretical limits of tandem cell (two layers of active material) could reach 55%. Multi-junction approach allows avoiding a problem of lattice matching requirements for different layers. It also increases theoretical limit of light to electricity conversion efficiency from 42% for tandem cells to 68% infinity-layer cells. Values exceeding 11% efficiency using mesoporous anatase TiO2 at one sun illumination have been achieved by Graetzel in 2006. In Graetzel cells, device stability associated with dye and electrolyte deterioration over prolonged use is an ongoing research issue. In dye-sensitized solar cells, it is advantageous to replace the liquid electrolyte with solid charge carrier material such as a polymer to form solid-state hetero-junction solar cells and avoid any sealing and long-term stability problems. Several hetero-junction interfaces will be studied in this project to understand the transport mechanism, charge separation, recombination and stability of the hybrid solar cells. TiO2 is widely recognized as one of the most promising photocatalysts for solar energy utilization, but its energy conversion efficiency has been severely limited by its intrinsic band gap of 3.2 eV. Here, we have established a novel p-n junction nanotube arrays to narrow the bandgap and enhance the photo generated charge separation for solar energy applications.

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