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Phase separated, self-assembled, vertically aligned epitaxial thin film heterostructures for photovoltaic solar cells

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Technology Summary

Recent advancements in nanostructural engineering offer great potential for the design, fabrication and creation of novel ordered structures with predictable physical and chemical properties for energy related technologies. However, synthesis and formation of chemically phase separated, but at the same time structurally self-assembled systems over a large scale present significant challenges, which include overcoming incoherent phase assembly, superlattice and random spatial ordering, and achieving appropriate combinations of materials due to control of thermodynamic equilibrium and strain coupling between the two phases. Development of thin film based multi-phase composite window/absorber materials with well-understood, customized and predesigned properties will ultimately lead to PV devices with increased overall cell efficiency, reliability, and considerably reduced cost. In general, self-assembly provides a spontaneous formation of vertical aligned nanocolumns that may consist of n- and p-type columns. Particularly for thin film based solar cell devices these nanostructures not only maintain a very high interfacial area needed for effective charge separation but also minimize defect formation in material. In addition, these structures offer longer electron diffusion length and shorter electron transport time than the layered thin films. In other words, nanostructured thin film made of vertical aligned nanocolumns provides a higher interfacial area between n- and p-type materials with highly efficient transport pathways. Moreover, by appropriate choice of window and absorber materials, having different energy band gaps, it may be possible to tailor/enhance the photo activity of the PV device, effectively targeting the absorbtion spectrum of the material system match to that of solar emmision spectrum.

Inventor

AYTUG, TOLGA

Chemical Sciences Division

Licensing Contact

CALDWELL, JENNIFER T
UT-Battelle, LLC
Oak Ridge National Laboratory
Rm 137, Bldg 4500N, MS: 6196
1 Bethel Valley Road
Oak Ridge, TN 37831

Office Phone: (865) 574-4180
E-mail: CALDWELLJT@ORNL.GOV

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