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Efficiency Increased in New Solar Cell: A Concept

A newly conceived solar cell, the graded band-gap cell, conceptually should be able to convert solar radiation into electrical energy more efficiently than any solar cell currently available. The new cell consists of a layer of $Al_{1-x}Ga_xAs$ (n-type semiconductor) on a GaAs p-type semiconductor base. In the $Al_{1-x}Ga_xAs$ layer, the Al concentration decreases from 80 percent at the cell surface to zero percent at the p-n junction (i.e., x increases from 0.2 to 1.0). Calculations, which include energy loss processes normally found in solar cells, show the air mass zero efficiency of this cell to be 16 to 17 percent compared to efficiencies of 13.5 percent reported for optimum silicon and gallium arsenide (heteroface) cells.

The new cell operates much like a conventional solar cell. Incident light enters the front surface (the indirect band-gap $Al_{1-x}Ga_xAs$ region) where some photons having energies equal to or larger than the energy band gap are absorbed. As photons travel deeper into this layer, the fundamental absorption character of the material changes, and the photons reach a direct band gap where those of sufficient energy are strongly absorbed. The photogenerated charge carriers (holes) are swept by an electric field, resulting from the band-gap variation, toward the junction where they are collected.

For this reason, it is very important that the thickness of the direct band-gap region be chosen to maximize both the quantity of light absorbed in this region and the fraction of photogenerated charge carriers collected at the junction. Depending on the thickness of the direct band-gap region, some fraction of the incident photons will reach the deeper p-type GaAs region where they will be absorbed. The charge carriers generated, electrons in this case, will again diffuse toward the junction where, if collected, they will contribute to power delivered by the cell.

Note:

Requests for further information may be directed to:

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Patent status:

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

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