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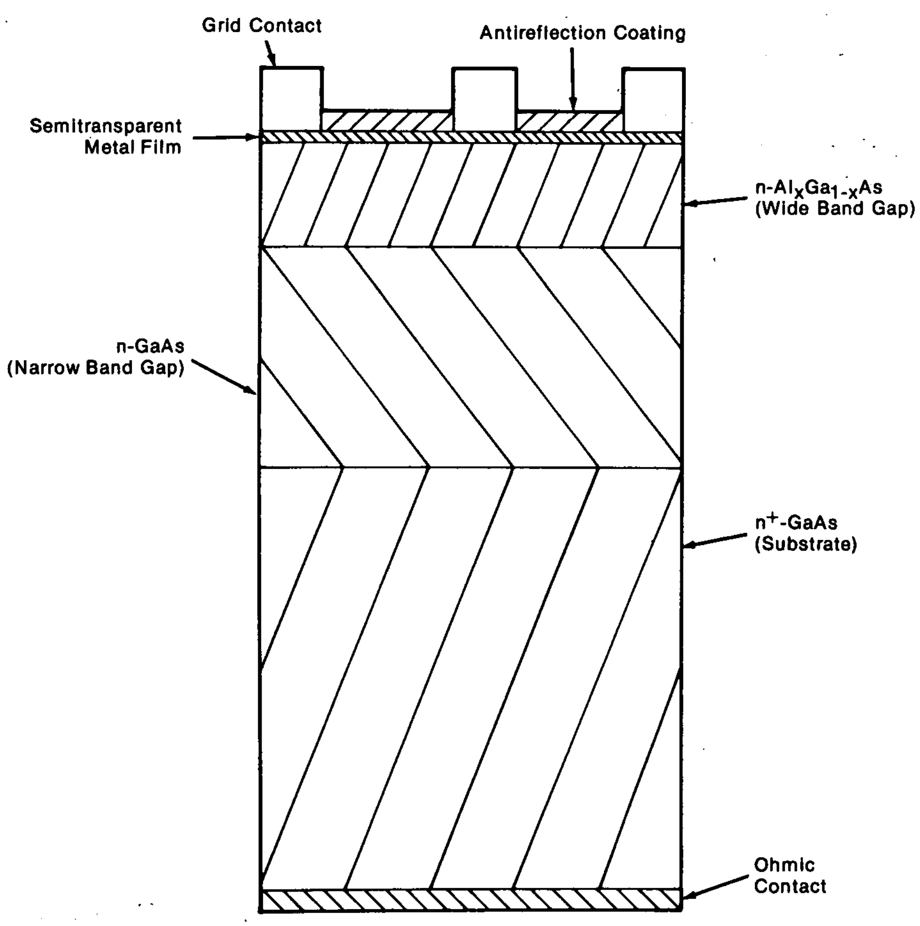
Schottky Barrier Solar Cell Promises Improved Efficiency

One of the major problems preventing the use of solar cells as a practical commercial energy source is their low efficiency (10 to 12 percent). A Schottky barrier photovoltaic cell [NASA Tech Brief B75-10119 (NPO-13390)] is expected to have an efficiency of about 45 percent over the narrow wavelength for which it was developed. This suggested that such cells might be modified to serve as solar cells for solar energy-conversion systems.

However, Schottky barrier cells deliver power at a low voltage due to the limited band bending in the GaAs semiconductors. This can be overcome by using even wider band-gap semiconductors to provide increased barrier height and band bending. Unfortunately, this leads to drops in current output because of the reduced solar absorption in the semiconductor. Both the low-voltage and low-current problems reduce the efficiency of the cell.



High-Voltage, High-Current Schottky Barrier Solar Cell

(continued overleaf)

This apparent dilemma can be overcome using a Schottky barrier device with a multiple-layer structure. With a wide band-gap semiconductor as the top layer and a lower band-gap semiconductor underneath, both higher current and higher voltage can be obtained. A significant amount of the solar radiation that is not absorbed by the wide band-gap material will be absorbed by the narrow band-gap material. Thus the current output is enhanced, while the high voltage from the high barrier height is retained.

The structure of the layered cell is shown in the figure. The thickness of the substrate n^+-GaAs is 4 to 8 mils (0.10 to 0.20 mm), and it is heavily doped to reduce series resistance and production costs. The n-GaAs and n-$Al_xGa_{1-x}As$ layers are the narrower and wider band-gap layers, respectively. They are sequentially grown epitaxially on the substrate. The upper (n-$Al_xGa_{1-x}As$) layer is several thousand angstroms thick (the order of 10^{-4} mm), and the lower (n-GaAs) layer is several microns (the order of 10^{-3} mm) thick.

The top layer may also be any ternary compound having a good lattice match with GaAs and the required electrical characteristics. The semitransparent metal film thickness is 100 Å (10^{-5} mm) or thinner. The contacts are a grid on the top surface and a metallic ohmic contact on the bottom of the substrate. The antireflection coating is applied over the metal film to reduce reflection losses.

Note:

Requests for further information may be directed to:

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Patent status:

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