MAR06-2005-000791

Abstract for an Invited Paper
for the MAR06 Meeting of
the American Physical Society

The Status and Outlook for the Photovoltaics Industry

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The first silicon solar cell was made at Bell Labs in 1954, and over the following decades, shipments of photovoltaic (PV) modules increased at a rate of about 18% annually. In the last several years, the annual growth rate has increased to $\sim$ 35% due largely to government-supported programs in Japan and Germany. Silicon technology has dominated the PV industry since its inception, and in 2005 about 65% of all solar cells were made from polycrystalline (or multicrystalline) silicon, 24% from monocrystalline silicon and $\sim$ 4% from ribbon silicon. While conversion efficiencies as high as 24.7% have been obtained in the laboratory for silicon solar cells, the best efficiencies for commercial PV modules are in the range of 17 18% (the efficiency limit for a silicon solar cell is $\sim$ 29%). A number of companies are commercializing solar cells based on other materials such as amorphous silicon, microcrystalline silicon, cadmium telluride, copper-indium-gallium-diselenide (CIGS), gallium arsenide (and related compounds) and dye- sensitized titanium oxide. Thin film CIGS solar cells have been fabricated with conversion efficiencies as high as 19.5% while efficiencies as high as 39% have been demonstrated for a GaInP/Ga(In)As/Ge triple-junction cell operating at a concentration of 236 suns. Thin film solar cells are being used in consumer products and in some building-integrated applications, while PV concentrator systems are being tested in grid-connected arrays located in high solar insolation areas. Nonetheless, crystalline silicon PV technology is likely to dominate the terrestrial market for at least the next decade with module efficiencies > 20% and module prices of < $1/Wp expected by 2020, which in turn should allow significant penetration of the utility grid market. However, crystalline silicon solar cells may be challenged in the next decade or two by new low-cost, high performance devices based on organic materials and nanotechnology.