MAR11-2010-003540

Abstract for an Invited Paper
for the MAR11 Meeting of
the American Physical Society

Film Si photovoltaics from high quality c-Si layers on inexpensive substrates[1]

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We develop crystalline silicon film photovoltaic (PV) technology to approach the efficiency of wafer silicon PV at thin-film manufacturing costs. Epitaxial c-Si layers can be grown by a fast, scalable hot-wire CVD technique at rates that exceed those of amorphous and nanocrystalline thin film PV by factor of 20, with quality approaching that of the crystalline Si wafer. This approach greatly reduces the absorber material costs that today account for about half the cost of a Si wafer PV module while bypassing the low growth-rate bottleneck that dominates thin film Si PV economics. As part of this equation, devices must also be fabricated on inexpensive substrates. To this end, we explore homo- and hetero-epitaxy at display glass-compatible temperatures as well as collaborate with several groups on promising high crystal quality seed layer technology. In the talk, we discuss key physics issues associated with film Si PV and describe recent experimental results, including: 1) device physics showing feasibility of 2 -10 microns thick c-Si PV absorber layers and their relative tolerance to defects and impurities; 2) demonstration of epitaxial cells on Si wafers with open-circuit voltages up to 600 mV; 3) understanding of high-rate, high-quality epitaxial growth in the temperature range 620 to 760C; 4) growth on seed layers on display glass and metal foils; 5) novel light trapping schemes that result in improved spectral response without texturing the growth template or etching away valuable absorber layer material.

[1]This work is supported by the U.S. Department of Energy Solar Energy Technology Program under Contract No. DE-AC36-99GO10337.