Abstract Submitted
for the MAR07 Meeting of
The American Physical Society

Silicon epitaxy onto silicon wafers above 600 °C by 100 nm/min hot-wire chemical vapor deposition

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National Renewable Energy Laboratory — We study a new silicon epitaxy regime by hot-wire chemical deposition onto silicon surfaces above 600 °C. In this regime, epitaxy proceeds at high growth rates (>100 nm/min) compared with lower-T growth, and does not appear to be thickness-limited. With a tantalum hot-wire operating at 1900 °C in SiH₄, we obtain phase-pure Si at 77 nm/min on (100)-oriented wafers at 650 °C. With a tungsten filament at 2100 °C, phase-pure epitaxy proceeds faster than 100 nm/min from 620 to 700 °C. Epitaxial growth up to 11µm thick is confirmed by transmission electron microscopy, x-ray diffraction and in-situ ellipsometry. This relatively low T epitaxial growth regime could be utilized for photovoltaic devices made by epitaxial thickening of c-Si seeds on low-cost substrate such as borosilicate glass. Temperature above 600°C and corresponding thermal dehydrogenation of the growing surface is critical for the high-quality, rapid epitaxial growth: between 450 and 600 °C, there appears to be an intermediate region where epitaxy is poor or nonexistent – even in comparison with epitaxy at 200 to 400 °C. The role of gas depletion chemistry, as well as structural/electronic quality is discussed.

1This work is supported by DOE contract #DE-AC36-99G010337.