Abstract Submitted
for the SES13 Meeting of
The American Physical Society

All-Optical Silicon-Based Modulators Driven by an Ultrafast Phase-Change Material[1] KENT HALLMAN, JUDSON RYCKMAN, ROBERT MARVEL, SHARON WEISS, RICHARD HAGLUND, Vanderbilt University — With increasing demand for higher-speed telecommunications, there is a need for optical modulators (OMs) designed to operate at the telecommunications wavelength. Although switching speeds of OMs compatible with current Si-based CMOS technology have increased recently, most devices are limited by the weak electro-optic effect in Si. We incorporated a phase-change material, vanadium dioxide (VO_2), into the model Si-based OM geometry, the silicon ring resonator (SRR). VO_2 thin films irradiated with ultrafast pulses can switch from their insulating ground state to an excited metallic state exhibiting different optical constants in a fraction of a picosecond. Capitalizing on this large, reversible refractive index change, VO_2 films with footprints <1 μm^2 have induced record phase modulations as high as $\pi/5$ rad/μm in these VO_2-enhanced SRRs. The resulting resonance shifts of almost 3 nm are $\sim$60 times larger than their silicon-only analogues. Using these devices, we have demonstrated both thermal switching induced with a cw laser and switching with $\sim$20 ns laser pulses. Since the VO_2 phase transition occurs in $<$100 fs, harnessing this light-induced ultrafast transition could be the key to designing ultrafast OMs.

[1]Air Force Office of Scientific Research Grant FA9550-10-1-0366

Kent Hallman
Vanderbilt University

Date submitted: 21 Sep 2013 Electronic form version 1.4