Terahertz all-optical modulation in a silicon-polymer hybrid system

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Abstract (Document Summary)

Although gigahertz-scale free-carrier modulators have been demonstrated in silicon, intensity modulators operating at terahertz speeds have not been reported because of silicon's weak ultrafast nonlinearity. We have demonstrated intensity modulation of light with light in a silicon-polymer waveguide device, based on the all-optical Kerr effect--the ultrafast effect used in four-wave mixing. Direct measurements of time-domain intensity modulation are made at speeds of 10 GHz. We showed experimentally that the mechanism of this modulation is ultrafast through spectral measurements, and that intensity modulation at frequencies in excess of 1 THz can be obtained. By integrating optical polymers through evanescent coupling to silicon waveguides, we greatly increase the effective nonlinearity of the waveguide, allowing operation at continuous-wave power levels compatible with telecommunication systems. These devices are a first step in the development of large-scale integrated ultrafast optical logic in silicon, and are two orders of magnitude faster than previously reported silicon devices. [PUBLICATION ABSTRACT]