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100 THz broadband optical switching with plasmonic metamaterial

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The development of coherent optical networks and processing are catalysing increasing attention as solutions to accelerate the data transfer speed and data processing. Conventional technology in coherent optical networks can perform at the maximum speed of 100 Gb/s. Here we evaluate the effect of plasmonic finite response time on the coherent perfect absorption process for a plasmonic metamaterial absorber, to achieve 100 Tb/s.

All-optical modulation means control of the phase or intensity of one light beam by another. In the coherent perfect absorption scenario, the interference of two counter-propagating coherent beams on a highly absorbing material of sub-wavelength thickness can either lead to nearly total transmission or to nearly total absorption of the incident light, depending on their mutual intensity and phase.

We study the coherent modulation of the total energy as a function of the pulse duration, from few hundreds fs down to 6 fs. Our measurements allow us to assess the maximal bandwidth for all-optical control of femtosecond pulses, which is about 100 THz. All optical switching also eliminate the disadvantages of optical–electrical–optical conversion thus opening a road to advances in terabits per second communications for high-performance communications and computing.

Our device based on coherent absorption has the advantage of being compact, intrinsically low power (as low as single photons), while demonstrating large modulations (modulation bandwidth ~7:1) and speed exceeding 100 THz has been observed. Finally we also evaluate the effect of nonlinearities on coherent modulation and its spectral dependence.