Generation of 11-fs Dark Pulses via Coherent Perfect Absorption in Plasmonic Metamaterial

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Dark pulses are dips in power of electromagnetic radiation on a constant background that are often accompanied by a phase jump across the intensity minimum. Since their discovery, dark pulses have attracted considerable attention in many fields such as dark solitons and optical communications. Here we report generation of 11 fs dark pulses using the regime of "perfect absorption". When two coherent counter-propagating electromagnetic waves of the same intensity form a standing wave, a thin absorber placed in the antinode of the wave could completely dissipate energy of both waves if its traveling wave absorption is 50%. If one of the waves is a "gate pulse" in time domain, the "perfect absorption" regime will exist only during the pulse, when a dip in power of "carrier pulse" will be created. "Dark pulses" are generated by positioning plasmonic absorber in the anti-node of the standing wave and balancing peak intensities. These dark pulses are characterized using cross-correlation technique. Measured width of the "dark pulse" is border than 6 fs "gate pulse", which is nearly 11 fs as shown in Fig. 1B. Width of the "dark pulse" is limited by transient plasmonic absorption establishes with completion of the plasmon relaxation time, which is typically 11 fs in gold nanostructures. We argue that bandwidth of dark pulses is limited by the plasmon relaxation time of the absorber.

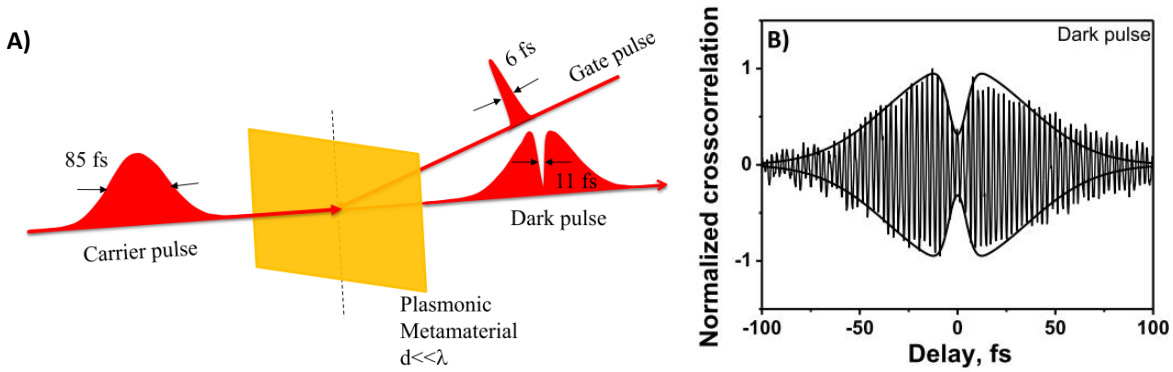

Fig. 1 A) Schematic of "dark pulse" generation in the envelope of "carrier pulse". B) Cross-correlation between generated "dark pulse" and 6 fs "gate pulse", dark pulses were generated by positioning plasmonic absorber in the anti-node of the standing wave, in the "perfect absorption" regime.