Picosecond laser pump, x-ray probe experiment on GaAs

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Following a proposal for a femtosecond-resolving x-ray detector [1], we measured the effect of femtosecond laser excitation of GaAs on the x-ray absorption cross section at the Ga K edge, using the Ga K alpha fluorescence yield as a measure of the x-ray absorption. An increase in the normalized Ga fluorescence of about 4 to 5 percent was observed with a persistence of about 200ps, which is consistent with the lifetime of laser-excited holes in the GaAs valence band. Further work could lead to an ultrafast x-ray detector [1], and to a spectroscopic technique with an absolute reference energy level for electron dynamics in photoexcited semiconductors.

[1] B. Adams, Proposal for a Femtosecond X-Ray Detector, Nucl. Instrum. and Meth. A 459, 339--346 (2001).

Coherent Control of Femtosecond X-Rays

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The propagation of x-rays under the conditions of dynamical diffraction is very sensitive to changes in teh crystal structure factor. This opens the possibility of coherent control of the propagating x-rays by inducing a rapid change of the structure factor with a laser, for example by massive excitation of coherent optical phonons. Just as a streak camera can reach a time resolution beyond typical RF frequencies, one may reach time constants which are less than the optical phonon frequencies. I have extended the Takagi-Taupin theory to explicitly include time-dependence and proposed several x-ray optical elements[1,2] which are based on the theory. Examples are an all-optical 'streak camera' with few-femtoseconds time resolution and a femtosecond-switchable x-ray phase retarder.

[1] B.W.A., conference proceedings no. 4500 of the SPIE; [2] B.W.A., Rev. Sci. Instrum, 3/02 in print.