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Novel methods to generate X-ray Transient Gratings

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Nonlinear X-ray wave mixing is a novel area of research that extend the field of nonlinear laser spectroscopy [1] into the short wavelengths regime. Transient grating, a four wave mixing technique, employs two crossed laser beams interacting at the sample to generate an interference pattern. This excitation grating induces dynamics in the sample that transiently changes the index of refraction and evolve over time. The change is detected by a time-delayed third laser beam (probe). Transient grating is widely used in the optical domain to gain information on transport and diffusion processes [2,3] as well as on charge-magnetic and vibrational dynamics [4-6]. However optical wavelengths are limited in the spatial and temporal resolution. With significan efforts, transient grating in the extreme ultraviolet has been demonstrated opening possibility to reach tens of nanometer spatial resolution with element selectivity in solids [7,8]. Extension of transient grating spectroscopy into the X-rays would allow to overcome the limitations of the longer wavelengths thus reaching the ultimate time-spatial resolutions (femtosecond –nanometer) adding chemical specificity. One of the main challenges is the generation of X-ray transient gratings due to the limited X-ray optics and the complexity of the experimental environment. In a series of experiments we have demonstrated the technique by generating X-ray transient gratings via Talbot effect [9] and probing with an optical laser [10] and X-rays at Free Electron Lasers. In this talk I will present the main results obtained in the experiments and explore possible novel methods to generate X-ray transient gratings in the future.

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