Temporal measurement of few-cycle laser pulses by third-harmonic dispersion-scan with optically improved graphene coatings

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Graphene - a single atomic layer of carbon atoms - is a very promising material, mainly due to its extremely high and broadband nonlinear optical susceptibility [1] and the possibility of occurrence of interband transitions at all optical frequencies. Ultrafast third-harmonic generation (THG) in graphene allows not only the temporal characterization of the used ultrashort pulses but also the study of carrier dynamics in graphene. The possibility of obtaining an enhanced nonlinear signal when using multi-layer graphene [2] further adds to these capabilities. The new technique of dispersion scan (d-scan) developed by Miranda et al. [3] enables characterizing ultrashort light pulses using an unprecedentedly simple and fully inline optical setup. In this method, the spectrum of a nonlinear signal (in this case, THG) is recorded for different amounts of dispersion applied to a light pulse, creating a 2D d-scan trace from which the spectral phase of the pulse can be retrieved and, therefore, by inverse Fourier transform, provides the exact temporal intensity profile and phase of the pulse. The most common nonlinear signal for d-scan has been SHG. For very broadband octave-spanning lasers or mid-infrared systems, it is helpful to use higher-order nonlinearities, like THG [4]. Here we present several examples of THG d-scan measurements of broadband few-cycle laser pulses obtained in graphene coatings produced by different production techniques [5], which enable characterizing the used ultrashort pulses while providing insight on the electronic dynamics in graphene. A typical THG d-scan trace obtained in multilayer CVD-grown graphene by using a chirped mirror and glass wedge compressor, together with the corresponding retrieved femtosecond pulse, is shown below.

REFERENCES

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FIGURES

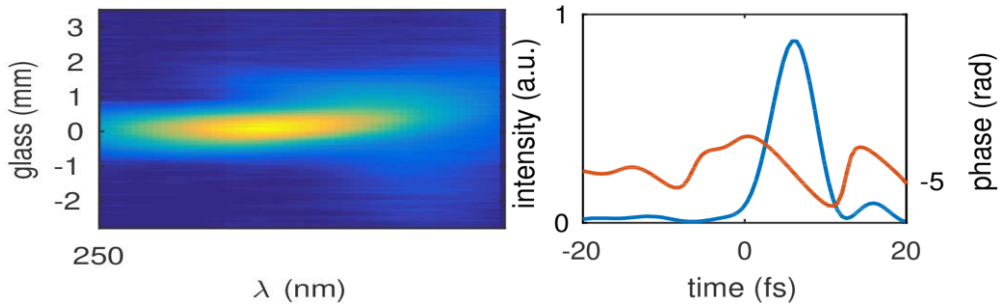

Figure 1: Typical measurement and reconstruction of a few-cycle laser pulse from a Ti:Sapphire oscillator – Third-harmonic signal as a function of dispersion (left) and temporal profile (blue) and phase (orange) of the retrieved few-cycle pulse (right).