Development of all solid-state phase-programmable femtosecond amplifier for wave packet engineering

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Development of all solid-state phase-programmable femtosecond amplifier is one of the important tools to realize interactive control of photonic and electronic wave packets. In the present paper, we investigated the performance of all solid-state Ti:sapphire amplifier. The original configuration of the amplifier is described in the literature.[1] A LD-pumped Q-switched YLF laser is used as an excitation source for the amplifier in order to achieve very high stability. The fluctuation of pulse energy as low as 5 % has been attained. The spectral width of the output is 45 nm, which determines the Fourier transform limited duration of the pulse. The compressed pulse duration is obtained to be 25 fs.

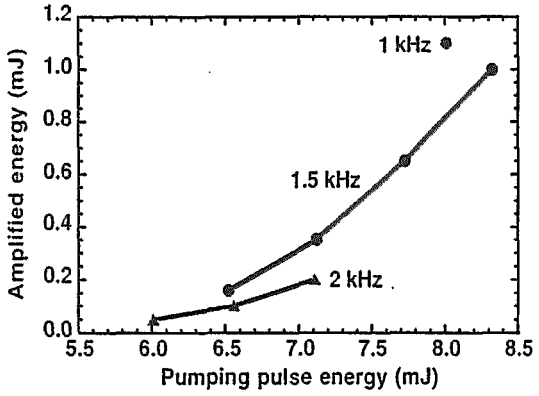

Fig.1: Dependence of the amplified pulse energy on the pumping energy at several repetition rate.

The typical repetition rate of Ti:sapphire amplifier has been 1 kHz. Higher repetition rates are desirable for nonlinear optical measurements of semiconductors. Figure 1 shows the amplified pulse energy as a function of the excitation pulse energy at several repetition rates. The total gain of the amplifier is lower at higher repetition rate even with the same pumping pulse energy. This may be due to the thermal loading inside the gain medium.

For wave packet engineering, a programmable phase modulator is combined to the amplifier. The phase modulator is composed of a pair of grating and spherical mirror, and liquid crystal spatial light modulator (LC-SLM) as shown in Fig. 2. A femtosecond pulse with a spectral band width as broad as 100 nm is converted onto the Fourier plane with the first set of grating and spherical mirror. The SLM on the Fourier plane provides phase shift to each spectral component. The pulse is reconstructed with the second set of spherical mirror and grating. Careful alignment results in pure internal phase shift with little angular dispersion.

The output from the phase modulator is characterized by frequency resolved optical gating (FROG). This is also depicted in Fig. 2. The temporal profile and phase information of the femtosecond pulses can be obtained from the FROG measurement. A desired phase pattern can be realized through the iterative adjustment of the phase mask by analyzing the phase information.

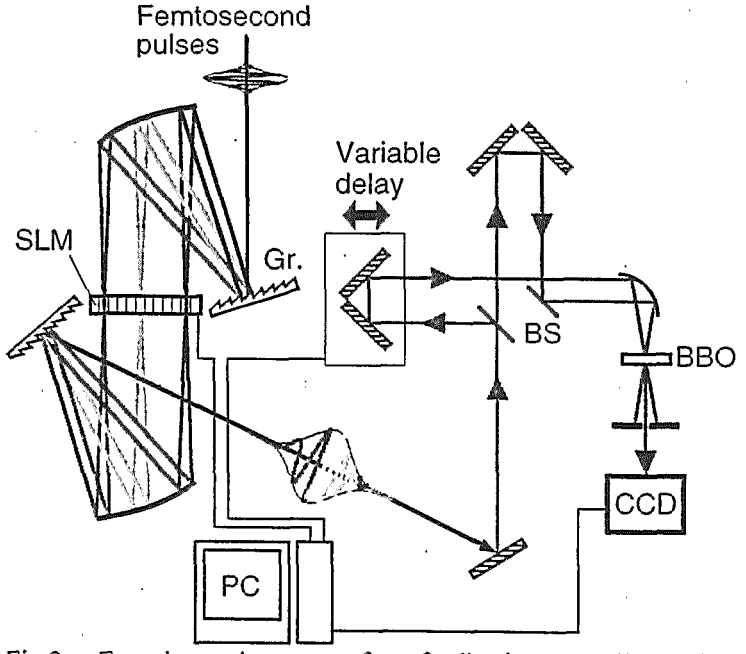

Fig.2: Experimental setup for feedback controlled phase modulator. SLM: Spatial light modulator, BS: Beam splitter

[1]S. Sartania et al. Opt. Lett. 22, 1562 (1997)