SPECTRAL BROADENING AND POST-COMPRESSION OF FEMTOSECOND PULSES IN ZnS AND KGW CRYSTALS AT 76 MHz REPETITION RATE

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An ongoing objective in laser physics is to attain increasingly shorter light pulses. For this, pulse spectral broading is required. An extension of optical bandwidth by self-phase modulation in the bulk media, followed by post-compression is a simple and robust method to achieve even shorter light pulses. By using multiple plate approach instead of one continuous nonlinear medium, peak and average power scalability is introduced, leading to no further losses in efficiency [1]. Further investigation of new bulk media with optimal characteristics is necessary to achieve pulse spectral broadening in high repetition rate (tens of MHz) and high average power near-infrared laser systems. Recent studies have demonstrated that zinc sulfide (ZnS) and potassium gadolinium tungstate ($KGd(WO_4)_2$, KGW) crystals are emerging as potential materials for this purpose due to their relatively high resistance to multipulse optical damage and high nonlinearity compared to commonly used fused silica and sapphire [1-3].

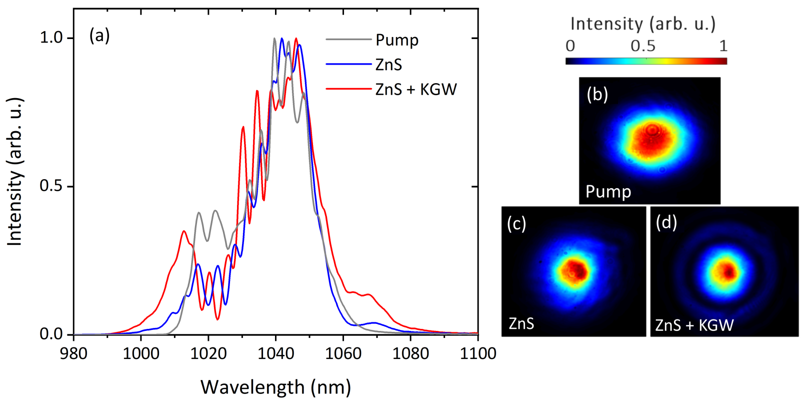

Fig. 1. (a) Comparison of spectral broadening in a single ZnS crystal and the double-pass ZnS+KGW setup. Far-field output beam profiles from pump (b), single ZnS crystal (c) and double-pass ZnS+KGW (d) setups.

In this work, double-pass spectral broadening setup consisting of first ZnS (2 mm) and second KGW (6 mm) crystals was investigated using an Yb:KGW oscillator (FLINT, Light Conversion Ltd.) with a single-pass pre-chip managed (PCMA) rod-type fiber amplifier system, which produced 75 fs pulses with an average power of 15.7 W and a central wavelength of 1038 nm at 76 MHz repetition rate [4]. Symmetric pump pulse spectral broadening due to self-phase modulation in single ZnS and ZnS+KGW setups is shown in Figure 1 (a). Beam profile measurements revealed no significant change in beam quality at the output of the single ZnS crystal setup [Fig.1(b,c)]. The second harmonic frequency-resolved optical gating technique (SHG-FROG) was used for temporal characterization of the pulses after the spectral expansion stage and post-compression stage, which was realized by Gires-Tournois interferometric mirrors. After the first and second stages of spectral broadening, the pump pulses were chirped over 100 fs and over 160 fs, respectively. Pulse compression was limited to 45 fs due to a rapid degradation of the beam quality with the further increase in pulse spectral expansion [Fig.1(d)]. Our results demonstrate a robust and versatile double-pass spectral broadening configuration, offering the potential for advancing the compression of high repetition rate femtosecond pulses which are relevant in the fields of ultrafast spectroscopy and microscopy.

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