Conference WS100: Technology and Applications of Intense, High Average Power Lasers Workshop

Thursday 27–27 April 2017

Part of Proceedings of SPIE Vol. WS100 Technology and Applications of Intense, High Average Power Lasers Workshop

WS100-18, Session PS

An all-reflective polarisation rotator

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The possibility of continuous adjustment of energy, or polarization state of high peak intensity ultra-short laser pulses is desirable in several applications. In most cases changing the energy continuously is difficult without affecting the time and spatial properties of the pulse. This can be done by rotating the polarization plane of the linear polarized laser beam and transmitting it through a polarizer. In some cases laser-matter interactions require the online rotation of the polarization plane, or changing linear polarization to elliptical. In most cases wave plates are used to do this. However wave plates have several disadvantages. Short laser pulses and hence broad bandwidth require using achromatic retarding plates. Those have a limited scalability in size and because of the substantial thickness can lead to the pulse broadening and inaccurate polarization rotation. A polarization rotator based on mirrors is a preferable alternative to wave plates especially when used in high average power or high peak intensity ultra-short laser systems. It has the advantage that the spectral transfer function is widely selectable, moreover the device is scalable for large beam diameters and the damage threshold is limited by the mirrors only, which is considerably higher than for wave plates. Contrary to wave plates, a reflective polarization rotator creates no post-pulses. Thus, the probability to generate related pre-pulses after recompression is minimized. The polarization rotator proposed consists of three mirrors fixed on a common plate which can be rotated around the optical axis. This rotates continuously the polarization plane of a linearly polarized laser beam at any desired angle. The device is a mirror - type analogue of the Dove prism, which is able to rotate an image continuously. If a mirror is polarization inactive the rotation of linear polarization produced by a mirror is exactly the same as the rotation of an image seen in the same mirror. This device is useful when the incoming linearly polarized beam has a stable polarization angle and there is a need for fast switching of polarization to either horizontal or vertical directions. Rotating the mirror assembly through 180° the plane of polarization can be continuously rotated through 360°, furthermore the input and output beams are collinear, therefore it is easy to insert the device into any existing setup. We present the conceptual design of the device and results of proof of principle experiments. Aluminum, silver, gold and dielectric mirrors were tested in the setup. Our measurement and calculation results show that upon reflection on a mirror, reflectivity ratio and phase shift difference for the s and p polarization components have influence on the polarization purity of the beam. Therefore the performance of the polarization rotator depends on the type of the mirror used, furthermore the polarization purity can be tuned with changing the angle of incidence on the mirrors.

WS100-19, Session PS

Pulse compression optimization of a picosecond high average power thin-disk laser

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We have developed picosecond high average power laser system based on an Yb:YAG thin disk. The system utilizes chirped pulse amplification. The chirped volume Bragg gratings (CVBG) are used for pulse stretching and compression. Additional chirped fiber Bragg grating (CFBG) is used in the pulse stretcher for optimization of the pulse width of the output pulse. The stretched pulses of an Yb-fiber laser oscillator at 1030 nm wavelength are injected into the first regenerative amplifier with linear cavity operating up to 100 W of the average output power. The second regenerative amplifier with ring cavity boosts the output power above 200 W.

The amplified pulses, from either of the stages, are compressed by the CVBG from 500 ps pulsewidth to few picoseconds pulsewidth. Use of CVBG enables to make the system compact and robust. The footprint of the CVBG is only few square centimeters. The Treacy type compressor with two diffraction gratings would require footprint of few square meters and is more demanding for alignment.

However, the CVBGs can suffer from thermal load caused by the residual absorption of the beam to be compressed at average power at the 100 W level and more. The axial and transversal temperature gradients in the CVBG are results of reflection of different spectral parts in different depths of the grating and Gaussian like beam shape, respectively. The inhomogeneous temperature inside the CVBG distorts the original periodicity of the grating, which leads to the mismatched pulse compression and worsening of the beam quality. The effects of the CVBG thermal load at different power levels on the pulse compression, spatial chirp, and M2 of the beam will be presented for different power levels. Further, results on the improvements of the compression by various approaches will be shown.

WS100-20, Session PS

Light hydraulic effect in laser nanodiamond synthesis, optimizing parameters for the output increase

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Nanodiamonds first discovered in 1963 in detonation soot are highly efficient in various processes, in electroplating, polymer compositions, polishing, lubricants and sintering [1]. However, the implementation of nanodiamonds in the industry is still restricted due to their insufficient homogeneity mainly caused by the non-controlled process of their fabrication by the detonation of explosives in closed chambers. Light Hydraulic Effect (LHE) was applied for laser assisted synthesis of pure and uniform nanodiamonds [2]. This method is based on the focusing laser radiation of high power density in liquid at some distance from specially prepared hydrocarbon target. A few approaches of technology optimization were considered theoretically: using solid state Q-switch lasers and fiber lasers with laser pulses in the range from femto to nanosecond pulse lengths with the delivered power density varying in the range of 10^7 – 10^10 W/cm^2 and maximally suitable repetition rate. Our lab technology proved that the optimization of laser parameters has a clear promise of raising the nanodiamond output by 2-3 orders of magnitude.

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