Sub-picosecond pulse break-up in an InGaAsP optical amplifier

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Abstract
For high speed optical communication system with data speed higher than 200 Gb/s sub-picosecond pulse dynamics, coherent effects become important. We have, experimentally and theoretically, investigated the pulse distortion of an 150 fs pulse due to amplification in a 250 μm long InGaAsP ridge waveguide, working at 1.52 μm, for different input pulse energies. Amplitude and phase in both frequency and time domain of the initial and amplified pulse were measured using a XFROG (Cross-Frequency-Resolved Optical Gating) technique based on sum-frequency cross-correlation. Measurements show a pulse broadening and eventual break-up for input pulse energies on the order of picojoules. This break-up is present in the gain region (6-14 dB), while for absorption (-6 dB) and transparency, pulse narrowing by a factor of two is evidenced. We observe that not only the amplitude is modulated, but also the linear chirp of the initial pulse is strongly modified. According to a numerical model, two-photon absorption and gain dispersion are responsible for the broadening and break-up. Kerr-nonlinearity at high intensities modulates the phase of the pulse and thereby the spectrum, which is evidenced in a spectral break-up. Due to gain dispersion, the spectral break-up results in a break-up in time domain.