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Short pulse generation using erbium-doped fibre based lasers and circuits.

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Recent advancements in the field of doped fibre fabrication using Rare earth ions e.g. Nd^{3+}, Er^{3+} have lead to the development of a large number of active all-fibre devices. Of particular note is the development of the erbium-doped fibre amplifier which is already leading to revolutionary developments for current telecommunication systems. As a result of the applications to the telecommunication industry a large number of commercial fiber components e.g. couplers, isolators, filters, modulators, gratings etc have been developed for use at 1.55 μm making the construction of complex, all-fibre, active functional circuits based on erbium doped-fibres a reality.

Besides the simple question of component availability and integrability the basic attraction of the fibre environment for short pulse generation is due to the broad gain bandwidth of erbium-doped fibres (40 nm) which permits the direct generation of ultrashort pulses as short as 80 fs and the fact that the high mode-confinement coupled to the long interaction lengths obtainable within fibres lead to a number of nonlinear effects e.g. self phase modulation, cross phase modulation, Raman self scattering and most importantly soliton effects. These phenomena can be used as the basis for passive mode-locking, pulse switching, shaping and compression. Most significantly, erbium fibre circuits have a natural tendency to generate transform-limited soliton pulses i.e. pulses which propagate stably without broadening within a dispersive media due to the combined action of the nonlinear and dispersive effects. Future ultrahigh bit-rate telecommunication systems are highly likely to operate with soliton pulses and erbium doped fibre lasers are strong candiates as sources.

In this presentation we describe the current situation relating to short pulse generation from active fibre circuits. We consider the applications, characteristics and ultimate potential of such devices and review the areas of both passive and actively mode-locked fibre lasers, soliton switching, amplification and compression. We conclude with a discussion of additional all-optical fibre-based techniques for the generation of ultrahigh repetition rate ($>$50 GHz) soliton pulse trains.