

**Ultrafast Low-Noise High-Power Fiber Lasers:
Applications from Material Processing to Optical Clocks**

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Ultrafast science impacts on nearly all areas of modern technology, and femtosecond lasers are invaluable tools in applications covering diverse fields such as materials processing, biomedical imaging, and frequency metrology. Advances in ultrafast science have always gone hand-in-hand with developments in laser technology. A femtosecond laser is, however, a complex device, rendering their operation difficult even in the hands of an experienced researcher. Fiber lasers are hailed as the solution thanks to their operational simplicity. CW and nanosecond fiber lasers have already captured a significant portion of the industrial laser-material processing market from Nd:YAG and CO₂ lasers. However, the propagation of short pulses in optical fiber necessarily leads to high intensities, ultimately limiting the performance of these lasers through the onset of nonlinear effects.

This talk will begin with a brief review of the state of the art of fiber lasers and the physics underlying their operation, including a new mode-locking regime, soliton-similariton regime that we have discovered [1]. This will be followed by an overview of applications we are currently pursuing: processing of biomedical materials and non-thermal ablation of tissue, sub-cellular surgery, development of optical-atomic clocks, remote sensing, as well as niche applications in ultra-precise RF signal generation.

[1] Oktem et al., Nature Photonics, 2010.