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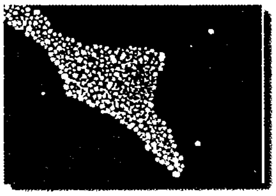
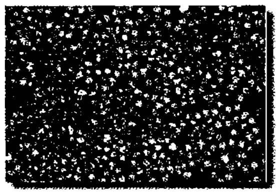
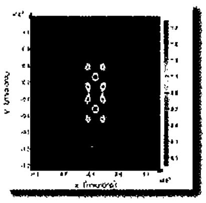
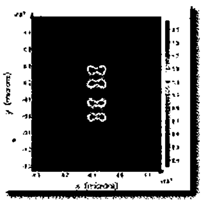
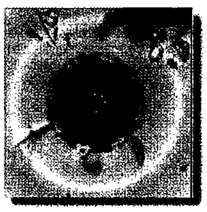




# Towards Functional Sub-Wavelength Photonic Structures







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# Pulse-pedestal discrimination by a soliton effect in a highly nonlinear photonic-crystal fiber

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Discrimination of an ultrashort light pulse from an extended low-power pedestal is one of the key operations on a short-pulse laser output often needed for a clean, physically unambiguous high-intensity-laser--matter interaction experiment and for high-quality optical signal transmission. Fiber-format pedestal suppression is of special value for rapidly growing fiber-laser technologies. Nonlinear Kerr-effect-induced polarization phenomena offer an elegant solution to the problem of pedestal suppression in the fiber format [1]. However, for femtosecond fiber sources, pedestal suppression without a substantial temporal broadening of the main peak is often necessary for high-field physics and optical information technologies. Here, we show that such a pedestal suppression can be realized for a short-pulse fiber-laser output by using soliton self-frequency-shift enhanced in a highly nonlinear photonic-crystal fiber (PCF) [2, 3].

In experiments, an ytterbium fiber laser mode-locked by nonlinear polarization evolution [4] was employed as a short-pulse laser source. The laser operated in the regime of positive dispersion at a 43-MHz repetition rate, delivering chirped 5-ps, 0.7-nJ pulses with a spectrum shown in Fig. 1a, compressible to a 140-fs pulse width upon chirp compensation. The autocorrelation function of the grating-precompressed fiber-laser output (open circles in Fig. 1b) shows a high-intensity 140-fs central pulse, containing up to 50% of the pulse energy, and an extended pedestal with a duration of about 1.5 ps.

To discriminate the femtosecond peak from the pedestal, the precompressed fiber-laser output was launched into an anomalously dispersive highly nonlinear PCF with a core diameter of 2.5 μm. Inside the fiber, the central, most intense part of the laser pulse evolves to a soliton, while the power of the pedestal is too low to contribute to the soliton and is further dispersed. The solitonic part of the field undergoes a continuous red shift due to the Raman effect, which spectrally isolates the soliton from the nonsolitonic part of the field (Fig. 1c). Dispersion of the fiber translates the spectral separation between the red-shifted soliton and the nonsolitonic part of the field into a time delay, helping to isolate the femtosecond soliton from the nonsolitonic part of the field in the time domain as well.

Enhanced nonlinearity of a small-core PCF provides a high efficiency of pulse--pedestal discrimination within a relatively short (1 to 2 m) piece of fiber and allows a pedestal suppression to be combined with a noticeable temporal compression (Fig. 1b) and controlled frequency shift of the most intense, solitonic part of the field, leading to the generation of high-contrast, pedestal-free 80-fs pulses with a milliwatt-range average power and kilowatt-level peak power at the output of an Yb-fiber-laser--PCF-discriminator system.

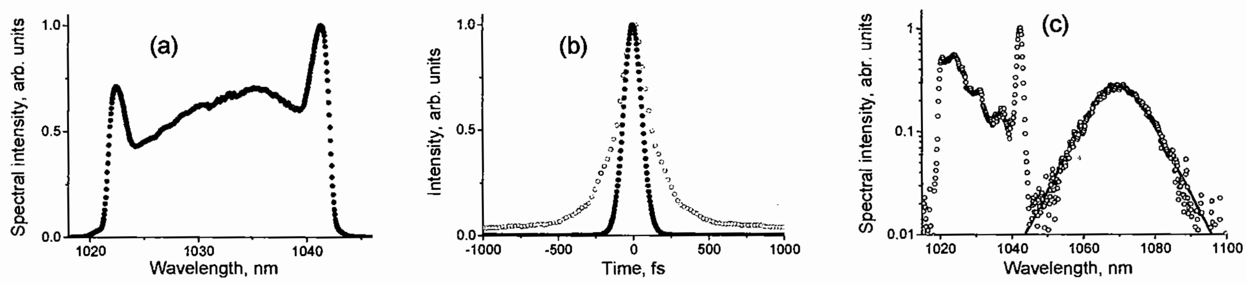


*Fig. 1. (a) The spectrum of the Yb-fiber-laser output; (b) an autocorrelation of the compressed fiber-laser output (open circles) and PCF output (filled circle); (c) the spectrum of precompressed Yb-fiber-laser pulses transmitted through a 160-cm-long piece of PCF (open circles) and a hyperbolic-secant fit of the red-shifted solitonic feature (solid line).*

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