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(G*) Wavelength-dependent depolarization in fiber-based supercontinuum

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Light possessing a broadband frequency spectrum, also known as a supercontinuum (SC), has facilitated a plethora of applications such as optical coherence tomography (OCT) and optical communication. In general, these spectra are produced by propagating narrow-band optical pulses through a highly nonlinear medium. Photonic crystal fibers (PCFs) are often used as the nonlinear medium for SC generation as their strong mode confinement capabilities over long distances lead to an increased nonlinearity. Although the polarization state of fiber-based SC sources can be crucial for the aforementioned applications, it is often overlooked due to the lack of proper experimental equipment operating over the entire spectrum. Here, we use a free-space, broadband, and polarization-resolving spectrometer to fully characterize the spectral intensity and linear polarization properties of a SC generated in a germania-doped silica PCF. More specifically, we investigate depolarization over more than two optical octaves as we vary the input polarization and pulse energy. We resolve self-phase modulation, self-shifted Raman solitons and dispersive waves within a set of orthogonal polarization states associated to the principal axes of the fiber as they contribute to generate a SC spanning from 450 to 2150 nm. We show that Raman soliton and dispersive wave generation remain axis-specific as they propagate in the PCF. Our experimental results feature a high degree of polarization at the edges of the spectrum in comparison to the region near the input pump wavelength. We show that this modulation is mostly caused by nonlinear spectral broadening. We also identify an additional depolarization mechanism preferentially acting on shorter wavelengths, indicative of a Rayleigh-like scattering effect due to the presence of intrinsic sub-wavelength defects in the fiber. Our results and experimental technique are a noteworthy step toward an improved standard for the characterization of broadband optical spectra and more efficient implementation of highly nonlinear fibers in a large range of polarization-sensitive applications like OCT.

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