Title: Impact of phase noise on coherence and spectral stability in dispersion-engineered supercontinuum generation in Si_3N_4 waveguides

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Abstract: Supercontinuum generation (SCG) in dispersion-engineered waveguides has enabled broadband, coherent light sources for applications ranging from spectroscopy to biomedical imaging. However, input phase noise can significantly degrade spectral stability and coherence, particularly across different dispersion regimes. This study investigates the impact of phase noise on SCG in silicon nitride (Si_3N_4) waveguides using numerical simulations of the generalized nonlinear Schrödinger equation (GNLSE) incorporating stochastic phase perturbations. Spectral broadening is analyzed in both anomalous and normal dispersion regimes using ensemble-averaged metrics such as spectral standard deviation and first-order coherence. The anomalous dispersion regime exhibits high coherence (near unity) and low spectral fluctuation ($\sigma \approx 0.06$), while the normal dispersion regime shows increased noise sensitivity, particularly for smaller waveguide cross-sections. These findings provide important guidelines for designing noise-resilient integrated supercontinuum sources.

Key words:

https://doi.org/10.1364/OPTCON.582717