521. Title:Ultrafast optical arbitrary-order differentiators based on apodized long-period gratings
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Abstract:We propose a novel, optimized design for arbitrary-order optical differentiation based on a uniform-period especially apodized long-period fiber or waveguide grating (LPG) operated in transmission. We show that the LPG solution can be optimized to utilize the entire grating resonance bandwidth for optical differentiation by properly customizing the LPG apodization profile through a discrete inverse-scattering grating synthesis technique. This strategy leads to a significantly increased processing speed and a maximized energetic efficiency as compared with previous unapodized LPG-based optical differentiator designs. As an example, optimized first-, second-, and third-order optical differentiators are designed using apodized LPGs implemented in standard single-mode fiber (SMF). The designed passive devices are practically feasible and offer an unprecedented operation bandwidth of 12 THz, which is capable of accurately processing time features as short as ∼ 100 fs, and an optimal energetic efficiency, which reaches a peak power spectral response of nearly 100% within their operation band.