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Development of Highly Nonlinear Extruded Lead Silicate Holey Fibers with Novel Dispersive Properties

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Holey Fibers (HFs) have generated enormous interest from areas as diverse as spectroscopy, metrology, biomedicine, imaging, telecommunication, industrial machining and the military. Recently, HFs made from compound glasses with high nonlinear refractive indices have attracted much attention for nonlinear device applications. In this study we used Lead-silicate (Pb) glass, which has proven to be a promising material for high nonlinearity HFs. Pb glasses offer high thermal and crystallization stability and less steep viscosity-temperature-curves with low softening temperatures, which allow the use of extrusion as an alternative fiber preform fabrication technology. Pb-HFs has a high material nonlinear refractive index and the index between the glass core and the air filled cladding enables tight mode confinement which results in a low effective area and thereby a high nonlinear coefficient. In addition, Pb has large normal material dispersion and bulk glass zero dispersion (ZD) wavelength at 1970nm, the tailorability of the cladding structure enables high flexibility in the design of the dispersion profile facilitating nonlinear effects, especially by the choice of ZD wavelengths at near IR region. This paper presents the development of small-core high-nonlinearity non-silica HFs with unique dispersive properties for compact nonlinear optics devices operating at low powers. To date, we managed to produce low-loss (2dB/m at 1550nm and ~1.5dB/m at 1060nm) Pb-HFs with very high nonlinearity coefficient up to ~2000$W^{-1}km^{-1}$. A dispersion model simulated using finite element method has demonstrated that Pb glass HFs with core size of 1.7μm are anticipated to enable ZD at 1060nm and with very high nonlinearities, which should allow efficient supercontinuum generation in compact devices using commonly available femto-second lasers as the pump sources. These results show that Pb-HFs are indeed promising components that contribute to the significant advancement in the miniaturization of compact nonlinear devices operating at low powers and offering appropriate dispersion.

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