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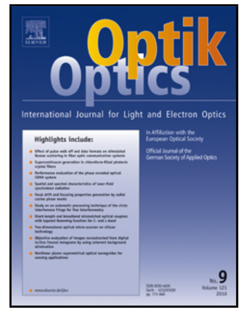

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Dispersion engineering of highly nonlinear rib waveguide for mid-infrared super continuum generation

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Abstract

A rib waveguide structure with a core of As2Se3 , upper cladding of air and lower cladding of MgF2 is proposed for generation of a very broad and flat supercontinuum spectrum. Generation of a flat and broad supercontinuum requires high pumping power, but increasing the power leads to material failure in the waveguide. Here we have designed a structure with a high nonlinear coefficient, which can generate a very broad and flat supercontinuum with a width of more than 11µm by using a pumping power of only 100W. To the extent that we have investigated the literature, there is no report so far on such a supercontinuum with only an input power of 100W in waveguides. The appropriate dispersion profile of the structure has resulted in zero dispersion wavelengths (ZDW) in two wavelengths of 2.1µm and 2.8µm. Therefore, the laser pump for the designed structure is also commercially available. The high refractive index difference between the core and the cladding, as well as the decrease of the pumping wavelength have led to the obtained small effective mode area. As a result, the high nonlinear coefficient of $65.4W^{-1}m^{-1}$ is obtained at the central wavelength of 2.4µm. Our numerical simulations and analyses indicate that by applying a laser pump with a pulse duration of 85fs and an input power of 100W to the proposed waveguide having only a length of 1cm, the output supercontinuum is achieved covering the wavelength range of 1.5µm to more than12µm, (at the -30 dB level from the peak).

Keywords: Chalcogenide glass; rib waveguide; zero dispersion wavelength; high nonlinearity; low loss; supercontinuum generation.

1. Introduction

Supercontinuum is a very broad spectrum which is generated by applying a very short pulse (in femtoseconds or picoseconds) at the waveguide input. This is due to the dispersion parameters and nonlinear effects of the waveguide. This spectrum has various applications from among which we can mention its use in coherent light sources utilized in various systems such as telecommunications, frequency metrology [1], spectroscopy [2], optical coherence tomography [3], molecular fingerprint spectroscopy, sensing and biomedical imaging [4]. Silica-core waveguides have low nonlinear coefficient and require high pumping power for supercontinuum generation [5]. Furthermore, due to increased absorption, they are not suitable for wavelengths of above 2.2µm [6-8]. For most of the above mentioned applications, a supercontinuum is required to broaden in long wavelengths. Hence, a material that is capable of propagating light in long wavelengths should be used in the waveguide core. Among these materials, we can name fluoride, telluride, bismuth, and chalcogenide that have relatively high nonlinear coefficient as well as having the capability to propagate light at long wavelengths. For example, using bismuth is reported to lead to a supercontinuum in the range of 2 to 5µm [9]. Fluoride glasses with transparency of up to 5µm have extensive applications in mid- infrared range [10-11]. Besides, in the telluride glasses used in a photonic crystal fiber, a supercontinuum with a wavelength of 0.8µm to 4.9µm has been reported [13]. However, due to the low nonlinear index of telluride,