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Supercontinuum generation in photonic crystal fiber

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ABSTRACT:During the last decade, the progress of supercontinua sources has arisen as a new research arena [1]. This is mostly due to new technological advances, which allows further controlled and manageable generation of supercontinua. This improved research has generated a diversity of new light sources which are finding uses in a various range of fields, including optical coherence tomography [2], frequency metrology [3], fluorescence lifetime imaging [4], optical communications [5], gas sensing [6] and various others. The articles assortment in this feature issue grants the most recent experimental and numerical studies of supercontinuum generation in diverse sorts of photic crystal fiber. It also familiarizes noveloutcomes of design and fabrication of these constructions with engineered dispersion, expansion of new diagnosticgears, as well as applications of spectral enlargement and supercontinuum generation for pulse compression,imaging, and sensing.

KEYWORDS: Supercontinuum, Supercontinuum generation, Photonic crystal fiber

I. INTRODUCTION

A supercontinuum is an extensive spectrum beyond all observable colors with the properties of a laser. In other words, a supercontinuum is coherent white light. The first surveillance of a supercontinuum generated in a photonic crystal fiber (PCF) dates back to 1999 by Ranka et al. [7].

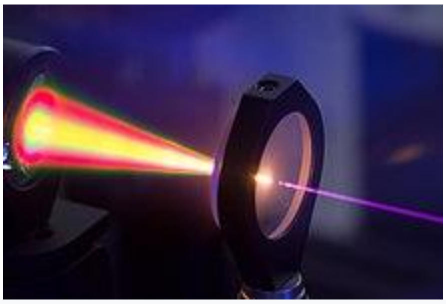

Figure-01: Image of a typical supercontinuum. This supercontinuum was generated by focusing 800 nm, sub-100 fs pulses into a yttrium aluminium garnet (YAG) crystal, generating ultra broadband light that spans both the visible and near infrared ray.

Photonic crystal fibers (PCFs) are special kind optical fibers that engage a microstructured alignment of material in a background material of dissimilar refractive index. The background material is often undoped silica and a low index region is typically provided by air voids running along the length of the fiber [8].

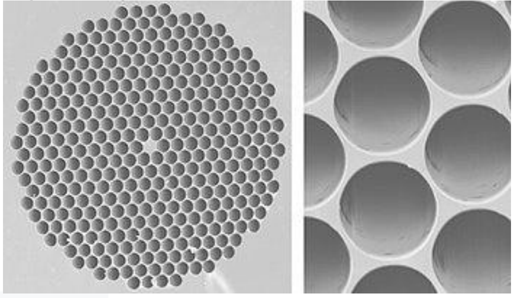

Figure-02: Scanning electron microscope (SEM) micrographs of a photonic-crystal fiber produced at US Naval Research Laboratory.

Supercontinuum generation is a process where laser light is converted to light with a very broad spectral bandwidth, i.e., a super-wide continuous optical spectrum. The improvement in photonic crystal fibers [9] makes the supercontinuumn generation comparatively simple. As one of the furthermost prosperous examples in nanophotonics, their applications have been testified ranging from sensors to lasers and to different types of passive and active waveguide device.

II. PAPERS REVIEW

The study convoyed herein covers a wide range of areas associated to several aspects of supercontinuum generation in photonic crystal fibers and waveguides, familiarizes noveloutcomes of design and fabrication of these constructions with engineered dispersion, expansion of new diagnosticgears, as well as applications of spectral enlargement and supercontinuum generation for pulse compression,imaging, and sensing.Below, we briefly highlight the main findings of the featured articles.

Authors showed the experimental and numerical result of supercontinuum generation in polarization maintaining photonic crystal fiber using a mode-locked Yb:KGW laser generating 52 nJ energy 90 fs duration pulses at 1033 nm with 76 MHz repetition rate [10]. In this article authors demonstrated the feasibility of spectrally broad and coherent supercontinuum generation in a photonic crystal fiber made of fused silica glass and infiltrated with nitrobenzene ($C_6H_5NO_2$) [11]. Mid-infrared supercontinuum generation in normally dispersive photonic crystal fiber (PCF) made of GeS_2-Ga_2S_3-CsI chalcohalide glass, was theoretically investigated where simulation results indicate that the all-normal regime of dispersion over the entire wavelength range was achieved by properly reducing the diameter of the core neighboring air holes [12]. A Sharafali& K. Nithyanandan theoretically proposed a novel liquid filled suspended core photonic crystal fiber as a new class of microstructure optical fiber for ultrabroadsupercontinuum generation [13]. Yang et al. report on the generation of broadband supercontinuum spanning 4.7 octaves, from 350 to 9000 nm, by multiple-filamentation in a lasermodified bulk PbF_2 crystal [14]. Ramachandran et al. investigate the effect of multiple scattering on supercontinuum generation by intense laser pulses in water containing randomly suspended polystyrene microspheres [15]. Diouf et al. report on the simulation of an ultrabroadband coherent mid-infrared supercontinuum extending from 1.25 to 20 µm and pulse compression down to 15 fs in a novel $AsSe_2$-As_2S_5 hybrid multimaterial photonic crystal fiber designed to have a zero-dispersion wavelength at 3.3 µm with an overall highly engineered group velocity dispersion shifted to the mid-infrared wavelength region [16]. Vengelis et al. investigate supercontinuum generation in a polarization-maintaining highly nonlinear photonic crystal fiber using subnanosecond pulses from Nd:YAGmicrolaser and show that a part of the supercontinuum light is generated in the cladding modes that exhibit different dispersion [17]. Eslami et al. show that the low damage threshold and power limitation associated with the use of soft glass fiber could be overcome by using large core multimode fibers and report the generation of octave-spanning supercontinuum from 1200 nm to over 2500 nm with 600 mW average power in a short length of multimode fluoride fiber with 100 µm core diameter [18]. Klimczak et al. report on the design, fabrication, and experimental characterization of highly nonlinear, tellurite glass photonic crystal fibers with engineered normal dispersion characteristics for coherent supercontinuum generation in the infrared spectral range [19]. Lemiere et al. experimentally develop arsenic- and antimony-free chalcogenide optical fibers with or without a suspended core and standard step-index fibers with varying core diameter and with low residual losses, used for supercontinuum generation with a spectrum spanning the 2–14 µm range [20]. Christensen et al. numerically study supercontinuum generation with femtosecond pulses in a silicon nitride waveguide and in a standard silica microstructuredfiber, and demonstrate that directional supercontinuum generation is observable in both fibers and integrated photonics waveguides with two zero-dispersion wavelengths [21]. Genier et al. present a detailed numerical study of the impact of pump laser amplitude noise on the coherence of the supercontinuum generated in all-normal dispersion photonic crystal fibers with femtosecond high peak power pulses [22]. Beetar et al. demonstrate near 20-fold compression of commercial Yb:KGW laser amplifier pulses in a relatively simple scheme utilizing a xenon-filled hollow-core fiber and chirped mirror compressor [23].

III. CONCLUSION

In this article, I have tried to combine articles related to creating supercontinuum generation in different photonic crystal fibers through different supercontinuum sources so that the newcomers to this research field can easily get an idea about related articles published in different renowned journals. I expect that this feature will provide a useful reference on the latest developments of supercontinuum generation in photonic crystal fiber and will stimulate further studies in this exciting research field.

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