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Editorial

Special Issue on "Advancements in Fiber Bragg Grating Research"

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Since the discovery of photosensitivity in optical fibers, there has been great interest in fiber Bragg grating (FBG) research. The ability to inscribe gratings in the core of optical fibers has revolutionized the field of telecommunications and optical fiber sensor technology. Four decades have lapsed since the first FBG reported, and the research on the fundamental as well as application aspects of these gratings has increased dramatically. The maturity in the subject has been seen in work presented in numerous journals and at conferences. It is reflected in the number of applications and developments, including design, fabrication, and characterization of fiber grating structures, fiber Bragg gratings in specialty fibers, advanced integration and interrogation of fiber gratings, and sophisticated fiber grating-based systems, which we continue to see flourishing and expanding. New discoveries have inspired the researchers and remain a driver for technological developments. In this Special Issue, we present some recent advancements to reflect these developments, keep in touch with the mainstream of topical research interest, and also touch on some relevant research.

An FBG generally is a reflective device with wavelength selectivity. There are many sidelobes on both sides of the reflection spectrum of a uniform FBG with high reflectivity. In UV FBG fabrication, the phase mask technique is the most traditional method to fabricate apodized fiber gratings to suppress the sidelobes in the reflection spectrum and reduce the time delay oscillation. Femtosecond laser can induce a permanent change in the refractive index of a quartz fiber and sapphire fiber, depending on the principle of multi-photon absorption. An energy regulation method based on the combination of a half-wave plate and a polarization beam splitter can be used for the fabrication of apodized fiber gratings in the femtosecond laser FBG fabrication process [1]. Nevertheless, phase-modulated fiber Bragg gratings can operate in transmission mode. A number of devices have been designed and demonstrated for in-fiber optical signal processing. In this Special Issue, all-optical arbitrary-order Hilbert transformers have been proposed and designed using phase-modulated fiber Bragg gratings in transmission at bandwidths up to 500 GHz [2]. In addition to most single-mode fiber Bragg gratings, the few-mode fiber Bragg grating (FM-FBG) has attracted considerable attention, used in the various applications, such as fiber filters, fiber lasers, fiber sensors, mode division multiplexing communication systems, and mode converters. The transverse asymmetry of the index modulation profile in an FM-FBG is found leading to mode conversion between modes with different azimuthal orders [3], which eases the realization of mode conversion.

Apart from owning all advantages of fiber sensors, an FBG has the distinct feature of wavelength coding, which offers direct absolute measurement and unique wavelength multiplexing capability and therefore has been widely studied and applied in sensing applications. A uniform FBG has recently found its new application in the temperature measurement for liquid food product pasteurization in a microwave oven [4], where electronic sensors can be dangerous or contaminant. A uniform FBG has been used in

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a spring-mass structure to constitute an accelerometer for the measurement of gravity and vibration. A nondimensional parameter is introduced to tune the sensitivity of an FBG-based oscillator-accelerometer [5]. An FBG can also be written in polymer optical fibers, showing distinct features of negative thermo-optic coefficients and an affinity for water. A comprehensive study of sensing performance of polymer optical fiber gratings at an extended temperature range is presented [6]. The uniform-period FBG is one of the earliest and most widely used gratings. The long-period fiber grating has also found its way into different sensing applications. In [7], a mechanically induced long-period fiber grating and a UV-inscribed long-period fiber grating are connected in cascade to provide simultaneous measurement of transverse load and temperature.

A novel type of long-period fiber gratings, the so-called helical long-period gratings (HLPGs), has drawn much research interest. HLPGs refer to fibers where there exists a periodic screw-type deformation in the core or an equivalent screw-type index modulation along the fiber direction. Recent progress in mode-coupling theories, fabrication techniques, and applications of HLPGs has been comprehensively reviewed in [8,9]. A great detail on HLPG applications in optical signal processing, such as mode converters, torsion sensors, band rejection filters, wave plates, linear- and circular-light polarizers, and OAM mode generators, can be found in [8], while more HLPG sensing applications, such as measuring the physical perturbation of torsion, strain, temperature, curvature, and surrounding refractive index, are presented in [9].

Other in-fiber devices, namely in-fiber interferometric-based sensors, are growing rapidly. Due to the in-fiber feature, these sensors exhibit many desirable characteristics compared with their regular fiber-optic counterparts. A thorough survey of recent research on in-fiber interferometric-based sensors is presented, in which different architectures are discussed and their basic configurations, operating principle, and recent applications are introduced in [10].

In this Special Issue, the contributions from researchers in different areas, including seven regular articles and three reviews, deal with the achievement in analysis, design fabrication of fiber gratings, fiber gratings in novel fibers, and novel applications. This only serves as a brief introduction to this fast-expanding area. We hope to be able to show the readers more exciting prospects in the future.

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