Introduction to the JSTQE Special Issue on Emerging Applications of Multimode, Multicore and Specialty Fibers

WELCOME to the IEEE JOURNAL OF SELECTED TOPICS IN QUANTUM ELECTRONICS (JSTQE) Special Issue on **Emerging Applications of Multimode, Multicore and Specialty Fibers**!

No one doubts today the optical fiber has completely transformed the way we all communicate and interact with the rest of the world. Over the past few decades, research on optical communications has focused on developing new optical fibers and multiplexing technologies to relentlessly increase the capacity offered by optical networks. In particular, the addition of the spatial dimension to the portfolio of optical multiplexing technologies, widely known as Space-Division Multiplexing, boosted the development of novel optical fiber systems and links including among others multicore, multimode and few-mode fiber solutions. The growing interest on these novel fibers has very recently opened up new avenues for research in emerging fields of application beyond long-haul optical communications, including radio access networks, data-center interconnections, imaging, automotive lighting and control, microwave signal processing, optical fiber sensing, medical monitoring or astrophotonics. The requirements imposed by the broad variety of these new application areas have resulted in the evolution of new families of specialty fibers in general, and space-division multiplexing fibers in particular, whose material and structure properties are tailored to achieve new properties and characteristics. This evolution calls on the expertise of a diversity of disciplines going from optics to materials science, electrical engineering, physics or chemistry, among others.

The main goal of this JSTQE Special Issue on **Emerging Applications of Multimode, Multicore and Specialty Fibers** is to highlight some of the latest leading-edge developments, challenges and trends in Space-Division Multiplexing fibers and other specialty fibers with application in a wide diversity of scenarios. The articles published in this issue cover a broad range of advanced optical fiber technologies and applications that can be summarized as follows:

- Multicore, multimode and few-mode fibers for high-capacity digital communications and submarine cable systems, with special emphasis on intercore crosstalk improvement techniques.
- Multicore, multimode and specialty fibers for optical sensing, including photonic crystal fibers, Brillouin analysis, the inscription of fiber Bragg gratings and the exploitation of opto-mechanical interactions in multicore fibers.
- Space-division multiplexing in astronomical applications.
- Multicore-based quantum optics.
- Low-loss hollow-core anti-resonant fibers.
- Remote spatio-temporal focusing over multimode fiber for biophotonics and telecommunications.
- Multicore fiber optical switching, data center systems and spatial channel cross-connect architectures.
- Nonlinear signal processing over few-mode fibers.
- Radiofrequency signal processing including optoelectronic oscillation.
- Different specialty optical fibers for communications, including among others bismuth defect bi-doped silica fibers, microestrucutred optical fibers and rectangular waveguides.

These key research topics are highlighted as comprehensive overviews of the current status and future trends, as well as original results and recent developments in the field. This special issue gathers together 32 papers, distributed in 8 invited and 24 contributed papers, reporting state-of-the-art research progress and breakthroughs accomplished recently by internationally recognized research teams in the field of multicore, multimode and specialty fibers. In particular, the invited papers include extended overviews on hollow-core anti-resonant fibers with lower optical losses and wider bandwidths, multicore multimode fiber with a 165-coupled-core structure for super-mode transmission, as well as multicore fiber optical switching systems with application in converged inter/intra data centers and edge networks. Spatial channel networks have also been reviewed with focus on novel spatial channel cross-connects and core selective switches. The portfolio of invited articles includes as well the exploitation of intermodal four-wave mixing to perform nonlinear signal processing in the context of all-optical wavelength conversion, the application of opto-mechanical interactions in multicore fibers to single-frequency optoelectronic oscillation and liquid point-sensing, the stable delivery of high-dimensional quantum states over a multicore fiber, and spatio-temporal mode focusing over multimode fiber enabled by single-ended channel estimation.

We hope you will find this JSTQE Special Issue on **Emerging Applications of Multimode, Multicore and Specialty Fibers** to be an interesting and useful reference that will impact, stimulate and promote further advances in the areas of space-division multiplexing and other specialty fibers.

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