NEW FIBER DESIGN SHINES LIGHT ON SINGLE-POLARIZATION SINGLE-MODE HOLLOW-CORE FIBERS

Significance

The effect of light polarization plays a vital role in many applications, such as; fiber lasers, fiber gyroscopes, optical communication networks, and interferometric devices. Narrowing down to optical fibers, environmental perturbations coupled with fabrication imperfections induce a random birefringence and lead to an unpredictable output. Consequently, this translates into an unwanted behavior in the two polarization eigenmodes which can ultimately lead to polarization instability as a result of the induced mode competition. Fortunately, this shortcoming can be fixed by using polarization-maintaining fibers, which have the capacity to eliminate evolution of the unpredictable polarization. However, further research input into this stabilizing mechanism is necessary as the efficiency of the currently used systems is not satisfactory. Moreover, it is beneficial to show computationally that fiber devices can be implemented in negative curvature fibers to filter and maintain the polarization, thereby enabling efficient and compact all-fiber devices.

Recently, the collaborative effort among Prof. Chengli Wei from the University of Mary Hardin-Baylor, Prof. Jonathan Hu from Baylor University, and Prof. Curtis R. Menyuk from the University of Maryland, Baltimore County led to a proposal for a relatively simple negative curvature fiber with a high birefringence and a high differential loss between the two polarizations of the fundamental core modes. Their goal was to find a fiber structure where the coupling between the cladding modes and the fundamental core modes in the two polarizations occurs within different parameter ranges. Their work is currently published in the research journal, *Optics Express.*

In brief, the research method employed encompassed the development of a polarization-filtering and polarization-maintaining negative curvature fiber in which two nested resonant tubes were added to a standard negative curvature fiber with one ring of tubes. They then utilized the coupling between the glass modes in the nested resonant tubes and the fundamental core modes. Lastly, they showed that the coupling between one polarization of the fundamental air core mode and the glass mode increases the birefringence and differential loss for the fundamental core modes in the two polarizations.

The authors showed computationally that the birefringence and the loss ratio between the modes in the two polarizations could reach 10^{-5} and 850, respectively. They also observed that the low-loss mode had a loss rate that was lower than 0.02dB/m. The researchers also commented that the developed fiber design made it possible to combine the nonlinear polarization rotation and polarization filtering in one device by splicing a standard fiber with the proposed fiber design, which enables fast saturable gain in passively mode-locked lasers and more efficient fiber laser designs.

In summary, the study proposed a novel polarization-filtering and polarization-maintaining negative curvature fiber that included two nested resonant tubes. Generally, the developed design contains at most two glass layers, which has been demonstrated to be feasible to fabricate. Altogether, the relatively simple design of polarization-filtering and polarization-maintaining low-loss negative curvature fibers will be useful in systems that require a polarization filter that can be integrated with other optical fibers.

About the author

Chengli Wei is an Assistant Professor in the Department of Computer Science, Engineering and Physics at the University of Mary Hardin-Baylor. He received B.S. degree from Tianjin University, M.S. degree from Nankai University in China, and Ph.D degree from Baylor University. His research interests include negative curvature fibers, chalcogenide glass fibers, photonic crystal fibers, nonlinear fiber optics, nanophotonics, and surface plasmons. He is a member of the Optical Society of America and the IEEE Photonics Society.

About the author

Curtis R. Menyuk was born March 26, 1954. He received B.S. and M.S. degrees from MIT in 1976 and his Ph.D. from UCLA in 1981. He has worked as a research associate at the University of Maryland, College Park and at Science Applications International Corporation in McLean, Virginia. In 1986 he became an Associate Professor in the Department of Electrical Engineering at the University of Maryland Baltimore County, and he was the founding member of this department. In 1993, he was promoted to Professor. He was on partial leave from UMBC from fall 1996 until fall 2002. From 1996–2001, he worked part-time for the Department of Defense, co-directing the Optical Networking program at the DoD Laboratory for Telecommunications Sciences in Adelphi, Maryland from 1999–2001. In 2001–2002, he was Chief Scientist at PhotonEx Corporation. In 2008–2009, he was a JILA Visiting Fellow at the University of Colorado. For the last 30 years, his primary research area has been theoretical and computational studies of lasers, nonlinear optics, and fiber optic communications. He has authored or co-authored more than 270 archival journal publications as well as numerous other publications and presentations, and he is a co-inventor of five patents. He has also edited three books. The equations and algorithms that he and his research group at UMBC have developed to model optical fiber systems are used extensively in the telecommunications and photonics industry.

He is a member of the Society for Industrial and Applied Mathematics and of SPIE. He is a fellow of the American Physical Society, the Optical Society of America, and the IEEE. He is the 1996–1999 UMBC Presidential Research Professor, the winner of the 2013 IEEE Photonics Society William Streifer Award, and a 2015–2016 winner of the Humboldt Foundation Research Award.

About the author

Jonathan Hu is an Associate Professor in the Department of Electrical and Computer Engineering at Baylor University. He received his Ph.D. degree from the University of Maryland, Baltimore County. Before he joined Baylor University in August 2011, he spent two years as a Research Associate at Princeton University. He has many years of research experience in optical sciences and engineering with expertise in the areas of mid-IR supercontinuum generation, chalcogenide glass fibers, photonic crystal fibers, nonlinear optics, nanophotonics, 2D materials, and surface plasmons. He has served as referee for more than 20 journals in optics, physics, and materials. He has also been session chairs for multiple international conferences.

He served as a topic co-chair for Mid Infrared Photonics (MIP) in the IEEE Summer Topical Meetings (2015) and a committee member in Novel Optical Materials and Applications Conference in OSA Advanced Photonics (2018). He received Baylor Young Investigator Development Award in 2015 and served as a Baylor Fellow in 2018.

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