Polarizing Properties of Photonic Crystal Fibers With High-Index Cladding Defects

Jie Li, Yuan Mao, Chao Lu, Member, IEEE, Hwa Yaw Tam, Senior Member, IEEE, and P. K. A. Wai, Senior Member, IEEE, Fellow, OSA

Abstract—The objective of this paper is to investigate the polarizing properties of the photonic crystal fiber with two high-index cladding defects. Using an intuitive field-distribution model, we demonstrate the origin of polarizing based on the coupling effects between the core and the defects. Considerably differential confinement losses and relatively broad operation bandwidths are achieved for the two orthogonal polarizations. Moreover, the fiber allows accurate control as both the operating wavelength and the bandwidth can be tuned continuously by modifying the refractive index of defects. The effects of changing the hole-filling fraction of the fiber and the positions of defects on the polarizing properties are also discussed.

Index Terms—Confinement loss, finite element method (FEM), photonic crystal fiber (PCF), single polarization.

I. INTRODUCTION

POLARIZATION control is important in optical fiber communication networks and sensor systems. Polarizing fibers or single polarization fibers that only allow one polarized state to be guided at certain wavelengths have been proposed [1]–[3]. Different from standard communication fibers, polarizing fibers can eliminate both the polarization coupling and polarization mode dispersion and have potential applications in improving the stability of an all-fiber system. Conventional polarizing fibers have been previously studied by utilizing an elliptic inner core [1] or a bending/absorption bow-tie structure [2], [3]. Recently, because of the great advantages of photonic crystal fibers (PCFs) including high-index contrasts and large flexibility of design, PCF-based polarizing devices have attracted increasing attentions [4]–[15].

A common approach in realizing polarizing operation is based on a highly birefringent PCF, which may include a twofold-symmetrically air-hole distribution [4]–[9], an anisotropic structured region [10], or a liquid-crystal-filled core [11]. Similar to a conventional structure, the fiber can be carefully designed such that the index of the undesired polarized mode is below that of the cladding and becomes unguided. For the purpose of polarizing, the method by integrating two depressed-index areas in a highly birefringent fiber has been suggested [12]. However, the non-Gaussian field profiles for such highly birefringent fibers will unavoidably increase the splice loss when they are connected to standard optical fibers. By introducing two stress-applying parts in cladding regions as the similar way to the conventional structures, the polarizing PCFs exhibit broad bandwidths as well as large mode areas [13], [14]. Polarizing photonic bandgap fibers have also been reported, through deformation of cladding lattice with an external CO₂-laser irradiation [15]. In this paper, we present a new polarizing PCF, which is achieved through integration of two high-index defects in the cladding lattice of an ordinary PCF. We investigate the effects of changing the fiber parameters on the polarizing properties.

II. PRINCIPLE AND NUMERICAL RESULTS

Fig. 1(a) shows the cross section of our polarizing PCF, which contains an array of hexagonally arranged air holes along the fiber length. The core is formed with the missing of an air hole in the center, as an ordinary index-guided PCF. The only difference is that the two high-index cores (HICs) are used to replace the two air holes in the cladding lattice. The background is assumed to be silica with refractive index of 1.45. The pitch constant and the hole diameters are represented by parameters λ and d, respectively. The cladding has an effective refractive index given by the fundamental space-filling mode (FSM), and thus light is bound through the mechanism of modified total internal reflection [4]–[11]. In the polarizing fiber, however, the light confined in the core can be transferred into the two HICs as propagation through coupling when an index-matching condition is satisfied. But because the HICs are so close to the boundary of the holey cladding, large confinement loss is inevitably introduced in the coupling process [16]. We adopt a full-vector finite-element method with perfectly matched layers (FEM-PML) [9], which can give rise to the complex effective indexes \( n_{\text{eff}} \) for the modes in the finite structure, as shown in Fig. 1(a). The confinement loss is expressed as \( \alpha = 8.69(2\pi/\lambda)\text{Im}(n_{\text{eff}}) \) in dB per unit length of the fiber, where \( \lambda \) is the wavelength in vacuum and \( \text{Im} \) stands for the imaginary part.

The coupling phenomenon, as shown in Fig. 1(a), in essence occurs between the two independent structures, i.e., the pure PCF and the HIC-PCF, as indicated by Fig. 1(b) and (c), respectively. The pure PCF is formed with removal of an air hole in the
core, while the HIC-PCF is similar to the pure PCF except that the fiber core has a high-refractive index. Fig. 2 depicts the mode dispersion curves for the PCF and the HIC-PCF, together with the sketches of the mode-field profiles, as shown in the insets. The hole-filling fraction $d/\Lambda$ is 0.45, and the center refractive index for the HIC-PCF is 1.70. As shown in Fig. 2, the pure PCF supports only the fundamental modes $\text{HE}_{11}^{\pi}$ and $\text{HE}_{21}^{\pi}$, while the HIC-PCF can support the fundamental modes $\text{HE}_{11}^{\pi}$ and $\text{HE}_{21}^{\pi}$ as well as the second-order modes $\text{TM}_{01}$, $\text{TE}_{01}$, $\text{HE}_{21}^{(1)}$, and $\text{HE}_{21}^{(2)}$. As shown in Fig. 2 (insets), the $\text{TM}_{01}$ mode has a rotationally symmetric field with the field vectors along the radial direction and the $\text{TE}_{01}$ mode has the field vectors along the azimuthal direction. Both $\text{TM}_{01}$ and $\text{TE}_{01}$ modes have the same effective index at the wavelength $\lambda/\Lambda = 0.530$, and at longer wavelengths, the effective index of the $\text{TM}_{01}$ mode is higher than that of the $\text{TE}_{01}$ mode. This is dissimilar to a conventional fiber where the $\text{TE}_{01}$ mode index is generally higher than that of the $\text{TM}_{01}$ mode [17]. However the $\text{HE}_{21}^{(1)}$ and $\text{HE}_{21}^{(2)}$ modes exhibit degenerate. From Fig. 2, there are several index-matched points between the fundamental modes for the pure PCF and the second-order modes for the HIC-PCF, corresponding to $\lambda/\Lambda = 0.570$ for $\text{TM}_{01}$, 0.561 for $\text{TE}_{01}$, and 0.525 for $\text{HE}_{21}^{(1)}$ and $\text{HE}_{21}^{(2)}$, respectively. We could, therefore, expect the strong coupling around these points.

In order to fully understand the coupling effects, we can place together a pair of waveguiding cells, i.e., the PCF and the HIC-PCF, and investigate the field distributions. It is known that the coupling should generally involve of a pair of supermodes, and the beating of these supermodes gives rise to the power exchange between two separated cores. Fig. 3 provides sketches of the four possible field profiles when the $\text{HE}_{11}^{\pi}$ (left) and $\text{TM}_{01}$ (right) modes are index matched in the two cores. Each polarization of $\text{HE}_{11}^{\pi}$ mode corresponds to two different field distributions. As shown in Fig. 3, the distributions (a) and (b) are the supermodes that can give rise to the mode beating as propagation along the fiber. In other words, both $\text{HE}_{11}^{\pi}$ and $\text{TM}_{01}$ modes can be coupled to each other in the two cores, from Fig. 3(a) and (b). On the other hand, the distributions (c) and (d) are in fact equivalent to each other, implying that the supermodes are simply degenerate, and therefore, the coupling phenomenon cannot occur between the $\text{HE}_{11}^{\pi}$ and $\text{TM}_{01}$ modes. Similarly, we can show that the coupling can happen between modes $\text{HE}_{11}^{\pi}$ and $\text{HE}_{21}^{(1)}$, $\text{HE}_{11}^{\pi}$ and $\text{TE}_{01}$, and $\text{HE}_{11}^{\pi}$ and $\text{HE}_{21}^{(2)}$. The same mechanism can be extended to the coupling system, as shown in Fig. 1(a), where only the coupling from the fiber core to the cladding defects is considered.

Fig. 4(a) plots the confinement loss factors $\alpha/\Lambda$ as functions of $\lambda/\Lambda$ for the polarizing PCF. The loss curves for the pure PCF are also provided for comparison. It is shown that the introduction of the cladding HICs has a strong influence on the loss curves. The strongest confinement losses appear at the wavelengths, where the mode indexes are matched in Fig. 2, with the HIC mode orders marked near the curves in Fig. 4(a). In contrast to the behavior of polarization degeneracy for the pure PCF, the introduction of cladding HICs in the polarizing fiber opens up two polarization-dependent windows, i.e., the $\text{TM}_{01}$ and $\text{TE}_{01}$ windows, as shown in Fig. 4(a). Owing to the introduction of high-index defects instead of the original low-index air holes in the cladding lattice, the confinement losses are increased over the whole wavelength region.

To express the dissimilarity of the confinement losses, a dimensionless factor $\Gamma$ is adopted [9], [12], which is defined as the ratio between the larger and smaller loss values for the two polarizations. Fig. 4(b) plots the variations of $\Gamma$ with $\lambda/\Lambda$ for
both the pure PCF and the polarizing PCF. While the pure PCF has its \( \Gamma \) values equal to unity, the polarizing fiber improves the \( \Gamma \) values greatly. From Fig. 4(b), we have \( \Gamma = 1.89 \times 10^4 \) at \( \lambda/\Lambda = 0.570 \) (TM_{01}) and \( 6.55 \times 10^3 \) at \( \lambda/\Lambda = 0.561 \) (TE_{01}), respectively. Although large confinement losses are obtained at \( \lambda/\Lambda = 0.525 \) (HE_{21} \( \text{and } \) HE_{22}), the \( \Gamma \) value is smaller than 5.0. This polarizing fiber can work with a relatively broad bandwidth. At the differential-loss ratio \( \Gamma = 100 \), we can have the normalized bandwidth \( \Delta \lambda/\Lambda = 5.22 \) for the TM_{01} window and 0.69 for the TE_{01} window, respectively.

As an example, with \( \Lambda = 2.72 \) \( \mu \)m, we have the resonant wavelengths \( \lambda = 1.55 \) \( \mu \)m (TM_{01}), 1.525 \( \mu \)m (TE_{01}), and 1.429 \( \mu \)m (HE_{21} and HE_{22}) from Fig. 2. Fig. 5 plots the electric-field profiles for both the \( x \)- and \( y \)-polarized modes in the polarizing PCF at \( \lambda = 1.55 \) \( \mu \)m when modes HE_{21} and TM_{01} are index matched. As expected, the \( x \)-polarized field has extended into the two cladding HIC regions, whereas the \( y \)-polarized field is confined well in the fiber core. The mode field areas are 12.8 and 11.6 \( \mu \)m\(^2\), and the confinement losses are given by 74.7 and 0.004 dB/m, for the \( x \)- and \( y \)-polarized states, respectively. Such large polarization discrimination in the confinement loss makes it possible for the fiber to be operated as a polarizing device. In a transmission system, if a signal power is attenuated by 20 dB, the signal is no longer deemed useful. For the present case, we can have the polarization-dependent loss higher than 20 dB over the fiber length 0.27 m, but only with the attenuation smaller than 0.001 dB for the desired \( y \)-polarized state. The estimated fiber lengths are 0.54 m for the \( x \)-polarized state to be attenuated by 40 dB and 5.06 \( \times \) 10\(^3\) m for the \( y \)-polarized state to be attenuated by 20 dB. The material absorption has been ignored. From Fig. 4(b), the TM_{01} window has a much broader bandwidth than that of the TE_{01} window. Calculation shows that the bandwidth for the former window is given by 14 nm at \( \Gamma = 100 \), with the wavelength varying from 1.545 to 1.559 \( \mu \)m.

III. EFFECTS OF CHANGING FIBER PARAMETERS

The properties for the PCF structure, as shown in Fig. 1(a), are determined by the refractive index of cladding defects, the hole-filling fraction, and the positions of the defects. In this section, we discuss on the effects of changing these physical parameters for the polarizing characteristics.

A. Effects of Changing the Refractive Index

From Fig. 2, increasing the refractive index of the defects can shift up the dispersion curves for the HIC-PCF and therefore push the index-matched points toward the longer wavelengths. Therefore, we can use the index-tunable material to control the fiber’s properties. For example, by integrating highly temperature- or electric-field-sensitive materials in the HIC regions, we can control the polarizing windows through the external temperature [18] or electric-field modulation [19]. Fig. 6(a) shows the operating wavelengths as functions of the refractive index for the TM_{01} and TE_{01} windows, respectively. The resonant wavelengths at HE_{21} \( \text{and } \) HE_{22} are also provided in the figure as references. As the refractive index is increased, the operating wavelengths increase continuously owing to the redshifts of the index-matched points in Fig. 2. Fig. 6(b) shows the variations of bandwidths with the refractive index for the two polarizing windows. Both the bandwidths increase monotonously with an increase in the refractive index. Moreover, the TM_{01} window has the much broader bandwidth than that of the TE_{01} window. As an example, as the refractive index is modified from 1.60 to 1.85 with \( \Lambda = 2.72 \) \( \mu \)m, we can have the operating wavelength varying from 1.175 to 2.025 \( \mu \)m and the bandwidth at \( \Gamma = 100 \) changing from 5.48 to 29.4 nm for the TM_{01} window.

B. Effects of Changing the Hole-Filling Fraction

As the hole-filling fraction \( d/\Lambda \) is increased, the mode curves and the FSM curves for the PCF drop, but the mode curves for the HIC-PCF rise in Fig. 2. Furthermore, increasing the \( d/\Lambda \) value can significantly lower the index-matched point between...
the TM$_{01}$ and TE$_{01}$ modes and therefore shift the positions of the polarizing windows accordingly. For the purpose of polarizing, however, the TM$_{01}$ and TE$_{01}$ windows should be well separated. Fig. 7 depicts the dispersion curves for the PCF and the HIC-PCF at a particular value $d/\Lambda = 0.657$. Fig. 8 plots (a) the loss factor $\alpha \lambda$ and (b) the differential-loss ratio $\Gamma$ as functions of $\lambda/\Lambda$ at $d/\Lambda = 0.657$. As shown in Fig. 7, the fundamental mode curves for the PCF intersect both the TM$_{01}$ and TE$_{01}$ mode curves for the HIC-PCF at the same wavelength point with $\lambda/\Lambda = 0.854$, which leads to the overlapping of the TM$_{01}$ and TE$_{01}$ windows, as seen in Fig. 8(a). As a result of this, the differential-loss ratios are smaller than 20 over the entire wavelength region, as shown in Fig. 8(b), and the polarizing bandwidths at $\Gamma = 100$ simply equal zeros.

When we further increase the hole-filling fraction, the crossing point between the TM$_{01}$ and TE$_{01}$ mode curves for the HIC-PCF is shifted below the fundamental mode curves for the PCF. The TM$_{01}$ and TE$_{01}$ resonant wavelengths in Fig. 8(a) are separated again. Fig. 9 depicts the dispersion curves for the PCF and the HIC-PCF at $d/\Lambda = 0.85$. Fig. 10 plots (a) the loss factor $\alpha \lambda$ and (b) the differential-loss ratio $\Gamma$ as functions of $\lambda/\Lambda$ with relation to Fig. 9. Different from Figs. 2 and 4, the TM$_{01}$ resonant wavelength falls between the TE$_{01}$ wavelength and the HE$_{21}^{(1)}$ and HE$_{21}^{(2)}$ wavelengths from Fig. 9, with the resonant wavelengths $\lambda/\Lambda = 1.045$(TM$_{01}$), 1.121(TE$_{01}$), and 0.998 (HE$_{21}^{(1)}$ and HE$_{21}^{(2)}$), respectively. Moreover, it is worth noting from Fig. 10(a) that the TM$_{01}$ polarizing window is localized at the valley of the TE$_{01}$ window, which may give rise to extremely large differential-loss ratios and a broad polarizing bandwidth around the TM$_{01}$ resonant wavelength, as shown in Fig. 10(b). As an example, with $\Lambda = 1.484$ $\mu$m and $\lambda = 1.55$ $\mu$m, we have $\alpha = 0.260$ dB/m and $1.61 \times 10^{-7}$ dB/m for the $x$- and $y$-polarized states, respectively, which produces the differential-loss ratio higher than $1.61 \times 10^6$. The bandwidth at $\Gamma = 100$ is 51.6 nm corresponding to the wavelength varying from 1.530 to 1.582 $\mu$m. In practice, such confinement losses can be further increased by decreasing the outmost air-hole size or introducing absorbent materials in the cladding defect regions [3].

Fig. 11 shows the variations of (a) the operating wavelengths and (b) the bandwidths at $\Gamma = 100$ with $d/\Lambda$ when the refractive index is fixed at 1.70. The resonant wavelengths at HE$_{21}^{(1)}$...
are also provided as references in Fig. 11(a). The wavelengths increase monotonously with an increase in $d/\Lambda$. The average sensitivities are 1.119 and 1.346 for each unit of the $d/\Lambda$ value at the TM$_{01}$ and TE$_{01}$ windows, respectively. For the condition $d/\Lambda < 0.657$, the TM$_{01}$ operating wavelength is longer than the TE$_{01}$ one. With the increase of the $d/\Lambda$ value, the bandwidths first increase and then decrease gradually for the two windows, consistent with the behavior of the gap between the operating wavelengths in Fig. 11(a). Generally, the wider the gap is, the broader the bandwidths are. As shown in Fig. 11(b), the maximum bandwidths occur at $d/\Lambda = 0.5$, corresponding to $\Delta \lambda/\Lambda = 6.203$ at the TM$_{01}$ window and 0.724 at the TE$_{01}$ window, respectively. As shown in Figs. 7 and 8, when $d/\Lambda = 0.657$, the operating wavelengths overlap and the bandwidths reduce to zeros accordingly. For the condition $d/\Lambda > 0.657$, the TE$_{01}$ operating wavelength is longer than the TM$_{01}$ one. From Fig. 11(b), the TE$_{01}$ bandwidth increases monotonously with an increase in $d/\Lambda$, consistent with the behavior of the gap between the two operating wavelengths. The change of the TM$_{01}$ bandwidth, however, is different. Owing to the relative positions of the TM$_{01}$ and TE$_{01}$ windows, as described in Fig. 10, the maximum TM$_{01}$ bandwidth happens at $d/\Lambda = 0.925$ with $\Delta \lambda/\Lambda = 46.73$. Beyond this point the bandwidth decreases dramatically. This is because the TM$_{01}$ operating wavelength approaches the HE$_{21}$ and HE$_{21}$ wavelengths very much, which consequently leads to the decrease of differential-loss ratios in the whole window.

**C. Effects of Changing Positions of Cladding Defects**

As described in Figs. 2 and 3, the polarizing effects are from the polarization-dependent coupling between the PCF core and the cladding defects. For the purpose of polarizing, the two defects should be put in a line through the fiber center in Fig. 1(a). Previously, we only studied the polarizing properties for PCFs with the cladding defects at positions “1,” as shown in Fig. 1(a). In practice, however, it is necessary to investigate the properties of structures when the defects are at different positions in the cladding. From Fig. 2, it can be understood that when we shift the positions of defects, the resonant wavelengths for the polarizing operation remain almost unchanged, but the confinement losses, as shown in Fig. 4, will be changed. Without loss of generality, in this section, we investigate the properties of structures with the high-index defects at three typical positions, namely, “1,” “2,” and “3,” as shown in Fig. 1(a). Compared to the positions “1,” the positions “2” become closer to the fiber core and the positions “3” are just located at the different points, i.e., the hexagonal vertexes, in the same ring of the cladding lattice. Table I shows the confinement losses for the high-index defects at three different positions, as shown in Fig. 1(a), with $\Delta = 2.72$ $\mu$m and $\lambda = 1.55$ $\mu$m in Fig. 2. When we move the defects from “1” to “2,” the confinement loss for the $x$ polarization drop dramatically while that for the $y$ polarization keeps almost unchanged, which consequently reduces the differential-loss ratio and is obviously detrimental for the polarizing operation. On the other hand, when the defects are shifted to “3,” the confinement loss for the $x$ polarization becomes much smaller than that for the $y$ polarization, different from the other two cases, as shown in Table I. Comparison shows that the different-loss ratio for the positions “3” is much larger than that for the positions “2,” and smaller than that for the positions “1.” We can therefore show that the positions “1” are the most optimized positions for the high-index cladding defects in PCFs for the polarizing operation.

**IV. CONCLUSION**

We investigate the polarizing properties of the PCF with two high-index cladding defects. With the help of the intuitive
field-distribution model, we show that the polarizing is originated from the coupling effect between the PCF core and the cladding defects. Under the index-matched condition, the coupling light undergoes a large confinement loss when it is transferred from the core to the defects. By means of a FEM-PML, both dispersion curves and confinement losses are analyzed in detail. In one such fiber, considerably differential losses 74.7 and 0.004 dB/m for the two polarizations are achieved at the wavelength 1.55 μm. This fiber allows accurate control as the two polarizing windows can be tuned continuously over a large wavelength range through modification of the refractive index of defects. The effects of changing the hole-filling fraction on the polarizing properties are also discussed. With the appropriate physical parameters, we can achieve a large bandwidth of 51.6 nm for the wavelength varying from 1.530 to 1.582 μm, within which the differential-loss ratio is higher than 100 between the two polarizations. Finally, we also investigate the influences of changing the positions of high-index cladding defects on the polarizing characteristics and demonstrate the optimized positions for the polarizing operation. This research provides a useful exploration for the cylindrical waveguides in the application of polarizing. Unlike most of other PCF devices [4]–[10], the structure can be realized either in the fiber drawing process or by infiltrating materials after the fiber is fabricated. The polarizer performance can be further improved through modification of air-hole size or integration of absorbent materials in the cladding defects [3].

### REFERENCES


### Jie Li

Jie Li received the B.S. degree in applied physics and the M.S. degree in optics from Nankai University, Tianjin, China, in 2000 and 2003, respectively, and the Ph.D. degree in electronic engineering from the City University of Hong Kong, Kowloon, Hong Kong, in 2008. From 2003 to 2004, he was at the Chuangnam Company Ltd., Shenzhen, China. From 2008 to 2009, he was a Postdoctoral Researcher at the Photonics Research Centre and the Department of Electronic and Information Engineering, The Hong Kong Polytechnic University, Kowloon, Hong Kong. In December 2009, he joined the Institute of Photonics Technology, Jinan University, Guangzhou, China, as an Associate Professor. His current research interests include optical fiber and waveguide theory, photonic bandgap structures, fiber-optics devices and technology, optical sensors, and nonlinear optics.

### Yuan Mao

Yuan Mao received the B.Sc. degree in academic talent program from Tsinghua University, Beijing, China in 2007. He is currently working toward the Ph.D. degree at the Photonics Research Centre and the Department of Electronic and Information Engineering, The Hong Kong Polytechnic University, Kowloon, Hong Kong.

His current research interests include photonic crystal fibers and their sensing applications.

### Chao Lu

Chao Lu (M’91) received the B.Eng. degree in electronic engineering from Tsinghua University, Beijing, China in 1985, and the M.Sc. and Ph.D. degrees from the University of Manchester, Manchester, U.K., in 1987 and 1990, respectively. From 1991 to 2006, he was with the School of Electrical and Electronic Engineering, Nanyang Technological University, Singapore, as a Lecturer, Senior Lecturer, and Associate Professor. From June 2002 to December 2005, he was seconded to the Institute for Infocomm Research, Agency for Science, Technology and Research (A*STAR), Singapore, as the Program Director and Department Manager, helping to establish a research group in the area of optical communication and fiber devices. Since April 2006, he has been a Professor in the Department of Electronic and Information Engineering, The Hong Kong Polytechnic University, Kowloon, Hong Kong. His current research interests include optical communication systems and networks and fiber devices for optical communication and sensor systems.

### Table I

<table>
<thead>
<tr>
<th>Positions</th>
<th>Confinement losses (dB/m)</th>
<th>Differential loss ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>x-polarization</td>
<td>y-polarization</td>
</tr>
<tr>
<td>“1”</td>
<td>74.7</td>
<td>0.004</td>
</tr>
<tr>
<td>“3”</td>
<td>0.056</td>
<td>0.004</td>
</tr>
<tr>
<td>“2”</td>
<td>6.11×10^-4</td>
<td>2.41</td>
</tr>
</tbody>
</table>
Hwa Yaw Tam (SM’00) received the B.Sc. degree in 1985 and the Ph.D. degree in 1990 in electrical and electronic engineering, both from the University of Manchester, Manchester, U.K.

From 1989 to 1993, he was with Hirst Research Center, GEC-Marconi Ltd., U.K., where he was engaged in research on wavelength-division-multiplexing components and systems and optical fiber amplifiers. His invention in low-loss fusion splicing technique for optical fiber amplifiers in 1990 is being adopted in commercial fusion splicers. In 1993, he joined The Hong Kong Polytechnic University (PolyU), Kowloon, Hong Kong, where he is currently a Chair Professor of photonics at the Department of Electrical Engineering and the Director of the Photonics Research Centre. He established several state-of-the-art research facilities at PolyU, including two fiber drawing towers and several laser platforms for the fabrication of advanced fiber gratings. He is the author or coauthor of more than 450 technical papers and awarded/applied about 20 patents. He also has strong R&D collaboration with industry. His team installed several condition-monitoring systems, which consist of 1000 fiber sensors for Hong Kong Rails and also a structural health monitoring system consisting of more than 200 optical sensors for the 610-m tall Canton Tower in Guangzhou, the world’s tallest TV Tower. His current research interests include fabrication of speciality glass and polymer fibers, fiber gratings, fiber amplifiers, optical fiber communication, and fiber sensor systems.

Prof. Tam is a Chartered Engineer and a member of the Institution of Electrical Engineers.

P. K. A. Wai (SM’96) received the B.Sc. (First Class Honors) degree from the University of Hong Kong, Hong Kong, in 1981, and the M.S. and Ph.D. degrees from the University of Maryland, College Park, in 1985 and 1988, respectively.

In 1988, he joined Science Applications International Corporation, McLean, VA, where he was a Research Scientist and engaged in research on the Tethered Satellite System Project. In 1990, he was a Research Associate in the Department of Electrical Engineering, University of Maryland, Baltimore. In 1996, he was an Assistant Professor at the Department of Electronic Engineering, The Hong Kong Polytechnic University, Kowloon, Hong Kong, where he became an Associate Professor in 1997, a Professor in 2002, and the Head of the Department, and where also in 2005 he became the Chair Professor of optical communications and the Dean of the Engineering Department, and has been an Associate Vice President since 2008. He is an active contributor to the technical field, having more than 100 international publications. His current research interests include theory of solitons, modeling of fiber lasers, simulations of integrated optical devices, long-distance fiber-optic communications, and neural networks.

Prof. Wai is a Fellow of the Optical Society of America, a Reviewer for many international journals, and was an Invited Speaker in international conferences.