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**UNITED STATES DISTRICT COURT  
CENTRAL DISTRICT OF CALIFORNIA**

INNEOS LLC,

Plaintiff,

v.

OPTICIS CO., LTD. and  
OPTICIS USA LLC,

Defendants.

Case No. 8:23-cv-00185-MCS-ADS

**DECLARATION OF ALAN E.  
WILLNER IN SUPPORT OF  
DEFENDANT OPTICIS CO., LTD.'S  
OPENING CLAIM CONSTRUCTION  
BRIEF**

DECLARATION OF ALAN E. WILLNER  
CASE No. 8:23-CV-00185-MCS-ADS

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**I. INTRODUCTION**

**A. Assignment**

1. I have been retained by counsel for Opticis Co., Ltd. (“Opticis Korea”) to serve as an expert witness in the above-captioned patent infringement action brought by Inneos LLC (“Inneos” or “Plaintiff”) against Defendant Opticis Korea and Opticis USA LLC (“Opticis USA”) (collectively, “Defendants”).

2. I understand that Inneos has asserted U.S. Patent No. 7,198,416 (the “’416 Patent” or “patent-in-suit”) against Defendants in the present litigation.

3. My opinions regarding the claim terms at issue, and what they would mean to a person of ordinary skill in the art (POSITA) are set forth in this declaration. I acknowledge that I am not a “patent attorney,” and for this reason I have relied on Opticis Korea’s counsel to explain to me the applicable principles of patent law that are relevant to my analysis and opinions.

4. I reserve the right to supplement or amend this declaration in light of any additional evidence and/or information that becomes available, or any other relevant factual or legal developments that affect my conclusions and opinions.

**B. Compensation**

5. I am being compensated at the rate of \$425 per hour for time spent working on issues in this case. My compensation does not depend upon the outcome of this litigation, the opinions I express, or my testimony.

**II. BACKGROUND AND QUALIFICATIONS**

6. A copy of my current curriculum vitae, which details my education and professional and academic experience, is attached as Appendix A to this report. The following provides an overview of some of my experience that is relevant to the matters set forth in this report.

7. My qualifications relevant to the subject matter of the patent-in-suit are summarized in this section.

1           8.     For more than 35 years, I have been involved in several areas of optical  
2 technologies, including devices, subsystems, systems, and networks for  
3 communications, sensing, and signal processing applications. A key technology that  
4 I have worked with is wavelength multiplexing.

5           9.     I have M.S. and Ph.D. degrees in Electrical Engineering from Columbia  
6 University, earned in 1984 and 1988, respectively. There, I received the Edwin  
7 Howard Armstrong Foundation Memorial Award for being the highest-ranked  
8 Electrical Engineering master's student. Additionally, I earned a B.A. in Physics  
9 (1982) and an Honorary Doctorate of Humane Letters (Honoris Causa) (2012) from  
10 Yeshiva University.

11          10.    Since 1992, I have been an Assistant, Associate, and Full Professor at  
12 the University of Southern California (USC). I have also been the Director of the  
13 Optical Communications Laboratory at USC since 1992. I am currently a  
14 Distinguished Professor and the Andrew & Erna Viterbi Professorial Chair in the  
15 Ming Hsieh Department of Electrical and Computer Engineering of the Viterbi  
16 School of Engineering at USC.

17          11.    From 1988 to 1990, I worked at AT&T Bell Laboratories as a  
18 Postdoctoral Member of the Technical Staff in the Photonics Networks and  
19 Components Research Department. From 1990 to 1992, I worked as a Member of  
20 the Technical Staff in the Photonics Research Department at Bell Communications  
21 Research (Bellcore). My work at both companies focused on wavelength-division-  
22 multiplexed (WDM) communication systems.

23          12.    From 1999 to 2002, I co-founded and served as CTO of Phaethon  
24 Communications, a company whose technology was acquired by Teraxion and that  
25 created the ClearSpectrum® dispersion compensator product line. ClearSpectrum®  
26 was marketed to WDM equipment manufacturers and has been deployed in many  
27 commercial systems worldwide.  
28

1           13. I have received various awards and honors. For example, I received the  
2 National Science Foundation Presidential Faculty Fellows Award from the White  
3 House, one of 30 recipients in 1994 in all areas of science and engineering. I am also  
4 a Member of the U.S. National Academy of Engineering, an International Fellow of  
5 the U.K. Royal Academy of Engineering, and a Fellow of the National Academy of  
6 Inventors. Moreover, I was the recipient of a Fulbright Foundation Senior Scholars  
7 Award, Guggenheim Foundation Fellowship, Packard Foundation Fellowship, and  
8 U.S. Dept. of Defense Vannevar Bush Faculty Fellowship (formerly the Defense  
9 Security Science and Engineering Faculty Fellowship).

10           14. Additional awards and honors that I have received include the  
11 following: Institute of Electronic and Electrical Engineers (IEEE) Eric Sumner  
12 Award for achievement in communications technology; IEEE Photonics Society  
13 Engineering Achievement Award; Optica (formerly Optical Society of America,  
14 OSA) Paul Forman Engineering Excellence Award; SPIE President's Award; IEEE  
15 Photonics Society Distinguished Traveling Lecturer Award; Optica Hopkins  
16 Leadership Award; Egleston Medal for Distinguished Engineering Achievement  
17 from the Columbia University Engineering Alumni Association; Institution of  
18 Engineering & Technology (IET) J.J. Thomson Medal for Electronics; Ellis Island  
19 Medal of Honor; Civilian Service Commendation Medal from the U.S. Dept. of the  
20 Army; IEEE Photonics Society Distinguished Service Award; and IEEE Globecom  
21 Best Paper Award. I also received the USC Associates Award for University-Wide  
22 Creativity in Research (highest university research award) and the USC Associates  
23 Award for University-Wide Excellence in Teaching (highest university teaching  
24 award). I am also a Fellow of the American Association for the Advancement of  
25 Science (AAAS), American Physical Society, IEEE, IET, Optica, and SPIE.

26           15. I have served in various professional activities, including: Co-Chair of  
27 the U.S. National Academies Committee on the "Optics and Photonics Study:  
28 Essential Technologies for Our Nation"; President of the IEEE Photonics Society (~

1 6,000 members); President of Optica (~20,000 members); Co-Chair of the Science  
2 and Engineering Counsel of Optica; Chair of the IEEE Technical Activities Board  
3 Ethics and Member Conduct Committee; General & Program Co-Chair of the  
4 Conference on Lasers and Electro-Optics (CLEO); Chair of the National Photonics  
5 Initiative; Program Chair of Telecommunications Engineering at SPIE's Photonics  
6 West; General Co-Chair of the IEEE Photonics Society Topical Meeting on  
7 Broadband Networks; and Chair of the Unclassified Technical Program for the IEEE  
8 MILCOM Conference.

9 16. My editorial positions have included the following: Editor-in-Chief of  
10 the IEEE/OSA Journal of Lightwave Technology (JLT); Editor-in-Chief of OSA  
11 Optics Letters; Editor-in-Chief of the IEEE Journal of Selected Topics in Quantum  
12 Electronics; Associate Editor of the IEEE Journal of Selected Areas in  
13 Communications (JSAC) Series on Optical Networks; and Guest Editor of JLT and  
14 the IEEE JSAC for the Joint Special Issue on Multiple-Wavelength Technologies &  
15 Networks.

16 17. I have been a Member of the U.S. Army Science Board and a Member  
17 of the Defense Sciences Research Council (a 16-member body that provided reports  
18 to DARPA Director & Office Directors). I have also served on many technical  
19 advisory boards, especially for small companies.

20 18. I have >1700 publications, including 1 book, ~10 edited books, ~25  
21 book chapters, ~54 keynotes/plenaries, >450 referred journal papers, and >300  
22 invited papers/presentations. I am a named inventor on >45 published U.S. patents  
23 in the fields of optical technologies, communication systems, signal processing, and  
24 networks. According to Google Scholar, my publications have been cited over  
25 42,000 times.

26 19. I have published hundreds of papers with the words "wavelength" or  
27 "WDM" in the title, not to mention many hundreds more that involve optical  
28 wavelength-dependent technologies in the papers themselves. One noteworthy

1 example is a paper published in *WDM Solutions Magazine* (Alan E. Willner,  
2 "Tunable Compensators Master Chromatic-Dispersion Impairments," *WDM*  
3 *Solutions Magazine*, pp. 51-62, July 2001). This paper received the 2001 Eddy Paper  
4 Award from Pennwell Publications for the Best Contributed Technical Article, and  
5 the selection committee considered papers from across all 30 magazines in  
6 Pennwell's Advanced Technology Division.

7 20. Over the past approximately 35 years, I have taught full and short  
8 courses (at universities and international conferences) on a variety of subjects,  
9 including optical fiber communication systems. I have taught thousands of students,  
10 including >60 graduate students who obtained their Ph.D. degrees under my  
11 guidance.

12 21. I have testified as an expert at trial or by deposition 5 times during the  
13 previous four years, as described in the following list:

- 14 • *Capella Photonics v. Infinera*, 2:20-CV-0077-JRG (E.D. Tex.)
- 15 • *Cosemi v. Everpro, Logitech, Fibbr, and Facebook*, 337-TA-1233,  
16 "Certain Active Optical Cables and Products Containing the Same" (ITC)
- 17 • *Branch Banking and Trust Co. v. Hitachi Vantara Corp.*, 1:19-CV-1168  
18 (M.D.N.C.)
- 19 • *Viavi Solutions Inc. v. Zhejiang Crystal-Optech Co.*, 2:21-CV-0378-JRG  
20 (E.D. Tex.)
- 21 • *WSOU Investments, LLC D/B/A Brazos Licensing and Development v.*  
22 *Xilinx, Inc.*, 20-cv-1231-GBW-JLH (D. Del.)

23 22. I consider myself to be an expert in the field relevant to the subject  
24 matter of the '416 Patent and to have the capability to understand and assess the  
25 relevant art and the level of skill and experience of a person of ordinary skill in the  
26 art ("POSITA") to which the '416 Patent is directed as of the time of the earliest  
27 alleged priority date (July 17, 2003). See below, Section VI(D) (describing a  
28 POSITA in the field relevant to the subject matter of the '416 Patent).

**III. MATERIALS REVIEWED AND RELIED ON**

23. I considered the documents, data, and other information mentioned and cited in this declaration in preparation of this report and the opinions set forth herein. For example, I have reviewed and considered at least the '416 Patent, the prosecution history of the '416 Patent, and the intrinsic and extrinsic evidence identified by the parties in the Joint Claim Construction and Prehearing Statement filed on November 8, 2023. *See* Dkt. 78. In addition to the documents, data, and other information mentioned and cited herein and in the Exhibits to this report, my opinions are also based upon my knowledge, education, experience, research, and training that I have accumulated over the course of my career, including more than 35 years of experience in the field of optical technologies.

24. I have also provided a declaration in support of Opticis Korea's petition for *inter partes* review (IPR) of the '416 Patent, which was filed with the Patent Office on July 28, 2023. The declaration in this corresponding IPR also describes the relevant technical background of the '416 Patent, summarizes the '416 Patent, and discusses claim construction issues, in addition to addressing the question of validity. I have also reviewed the material cited in my declaration in the corresponding IPR, and my opinions in that declaration, which are consistent with the opinions I provide herein.

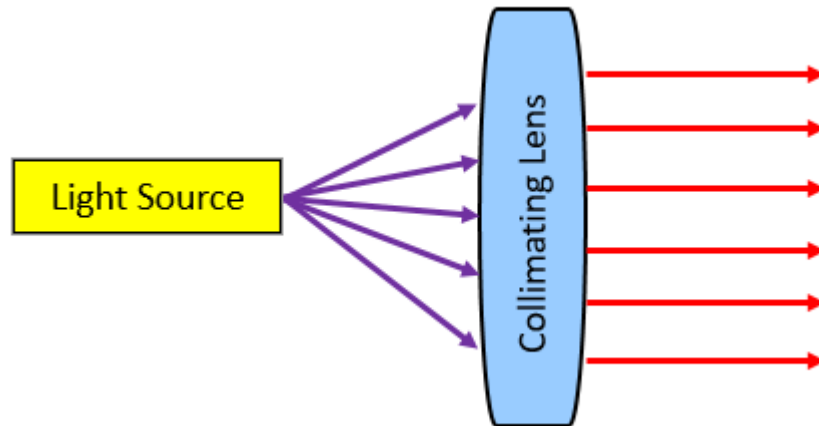
25. In testifying, I may use some or all of the documents, data and other information identified in this report and the testimony, exhibits, documents, additional data or other information identified in discovery, as well as any materials relied upon by Plaintiff or Plaintiff's experts, to support or summarize my opinion.

**IV. TECHNOLOGY BACKGROUND**

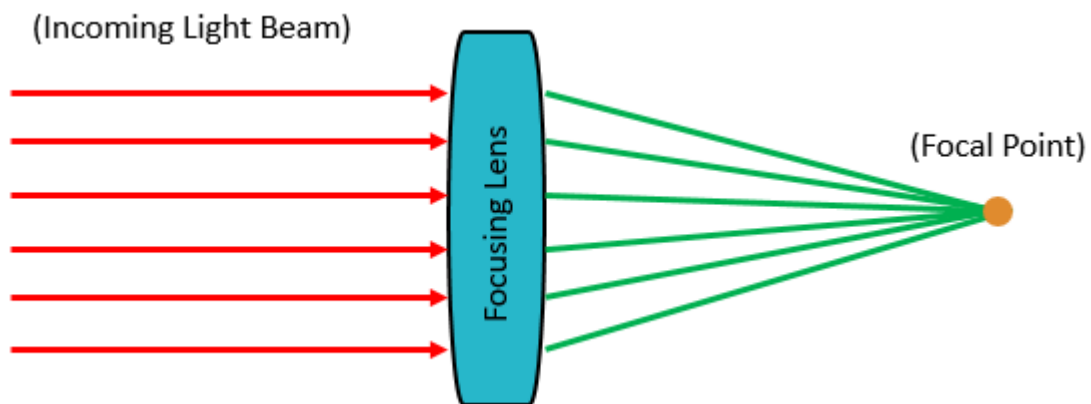
**A. Collimating and Focusing Lenses**

26. There are various types of lenses. Conventionally, lenses allow light to pass through them, as well as focusing or diverging the light beam via refraction depending on the type of lens and the source of light. As one example, a collimating

1 lens is a lens that is capable of converting a divergent beam of light into a collimated  
2 beam, i.e., a beam that propagates without a substantial change in the beam width  
3 over some propagation distance. An illustration of this follows (with a single  
4 divergent beam in purple and a single collimated beam in red). Multiple such  
5 collimated light beams can propagate in an approximately parallel fashion.

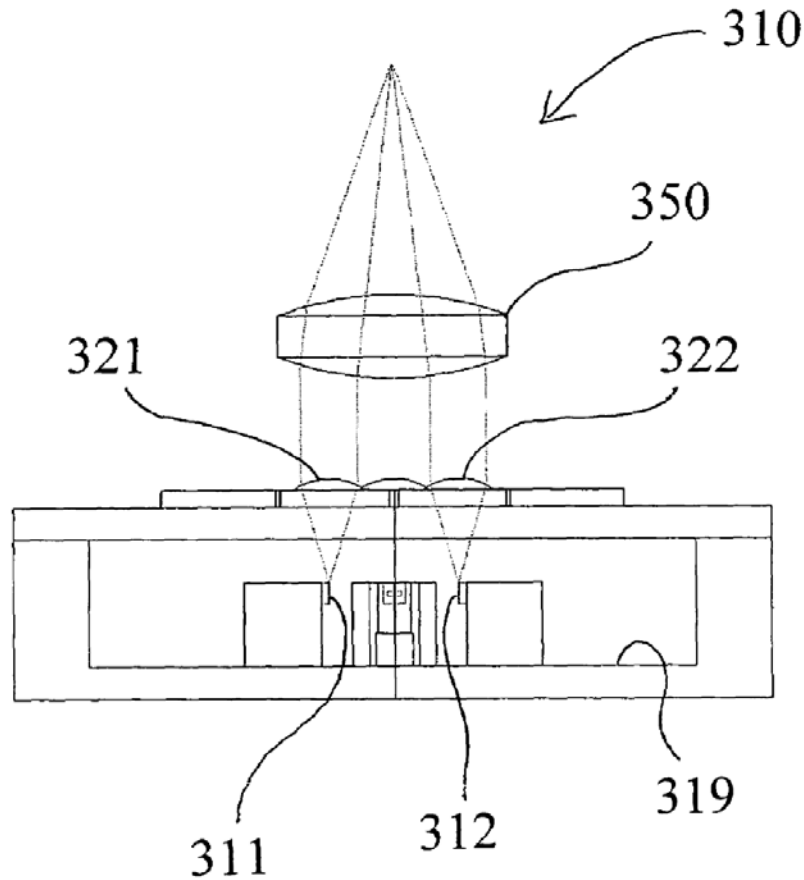


15 27. Another example of a lens is a focusing lens, which is capable of  
16 focusing a collimated light beam to a single spot. This spot is referred to as the focal  
17 point of the lens. An illustration of this follows:



26 28. Collimating lenses and a focusing lens are shown, for example, in FIG.  
27 10 of the '416 Patent. Lasers 311 and 312 are sources of light, lenses 321 and 322  
28

1 collimate light from lasers 311 and 312, and lens 350 focuses the collimated light.  
2 See '416 Patent, 4:42-52 and FIG. 10 (reproduced below).



18 29. In an optical device, such as an optical combiner, multiple lenses may  
19 be used to form a lens system. The lenses work together so that, for example, in an  
20 optical combiner, multiple inputs are coupled into an output.

### 21 **B. Optical Combiners**

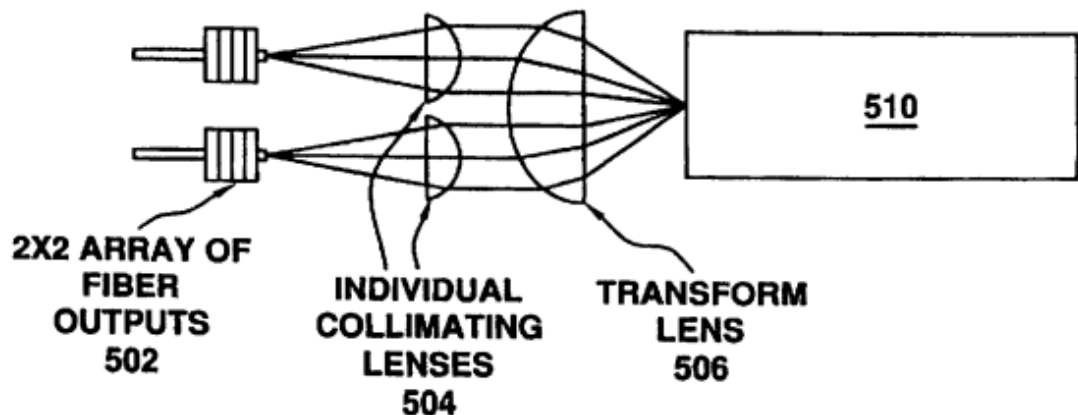
22 30. An optical combiner *combines* multiple optical inputs into an output,  
23 *e.g.*, the light from N lasers into a single optical fiber. One example of an optical  
24 combiner is an optical multiplexing device. *E.g.*, '416 Patent, 1:34-42.

25 31. An optical combiner may include a lens system for combining the  
26 multiple optical inputs into an output. However, there are optical combiners that do  
27 not include a lens system. For example, gratings and filters may be used instead of  
28

lenses. Where the multiple inputs of an optical combiner each have a different wavelength, the optical combiner may support wavelength division multiplexing (WDM). But there are optical combiners that are not necessarily designed to support WDM. For example, the '416 Patent refers to one of these combiners, i.e., the Lee et al. reference (U.S. Patent No. 5,377,287) referred to in the background of the '416 Patent. '416 Patent, 1:56-2:10 ("the Lee et al combiner does not multiplex n different wavelength channels").

32. There are many uses for optical combiners. For example, optical combiners may be used in amplifiers; for medical purposes, such as lasers in surgery; or for material processing, such as welding and cutting. An example of some of these uses is provided in U.S. Patent No. 5,715,270 to Zediker et al. ("Zediker"). See OpticisKR0003524-38 ("Zediker"). Zediker discloses an optical combiner having a structure similar to the one disclosed in the '416 Patent, including a 2x2 input array, corresponding collimating lenses, and a focusing lens. This is shown in FIG. 9:

**FIG.9**



Zediker, FIG. 9. See also *id.*, 1:23-26 ("More recently, arrays of semiconductor lasers have also been utilized in which adjacent emitters of the array of

1 semiconductor lasers spaced upon the same substrate are coupled together.”), 3:8-11  
2 (“By utilizing a plurality of one-dimensional semiconductor laser arrays 10 whose  
3 outputs may be combined, the output power of the two-dimensional semiconductor  
4 laser array may be quite high.”), 4:19-26 (“It would be desirable for a plurality of  
5 semiconductor laser arrays to produce a single spot of high intensity laser output  
6 using a simple and robust optical subsystem. Furthermore, it would be desirable for  
7 a plurality of semiconductor laser arrays to be mounted evenly and the outputs thereof  
8 collimated in such a manner as to fill the available aperture to thereby provide a  
9 substantially constant intensity across the single spot of laser output  
10 produced.”), 6:42-46 (“The block diagram of FIG. 5 illustrates a DLS 1, in which the  
11 optical output laser beams of 4 LHAs 400, each producing 800 watts of power, are  
12 combined to deliver over 3200 watts of cw power to a single focusing lens. As  
13 discussed in greater detail below with respect to FIG. 9, the output of each respective  
14 LHA 400 advantageously can be fiber coupled and at the distal end of each fiber  
15 (approximately 1 mm diameter) they can be recollimated. The 4 collimated laser  
16 sources, i.e., the 4 output optical beams, preferably are collected by a single lens,  
17 which focuses the 3200 watts of total power onto a single point. It will be appreciated  
18 that this latter technique is commonly used in industrial laser systems to increase  
19 fluence on the work piece.”).

20 33. Zediker describes some of the applications for such a system, which  
21 range from weapons, to welding, to surgery:

22 In numerous applications such as laser tracking, laser guidance and  
23 laser imaging, it is desirable to produce a high power coherent laser  
24 output. Moreover, high power coherent laser systems find  
25 applications in such diverse fields as offensive and defensive weapon  
26 systems, e.g., non-visible light illuminators for special operation  
27 forces and protective laser grids, as well as material processing, e.g.,  
28

1 welding, cutting, heat treating and ablating, and medicine, e.g.,  
2 surgical and diagnostic aides.

3 *Id.*, 1:10-18; *see also, e.g., id.*, 10:9-15 (“Those of ordinary skill in the art will  
4 appreciate that the commercial applications range from surgery, to cutting,  
5 welding, and heat treating metals. In addition, this DLS 1 will be ideal for paint  
6 stripping, curing, cutting and drilling composite materials. Military  
7 applications range from an off-gimbal illumination system to a delay denial  
8 system for nuclear storage areas.”).

9 34. Optical combiners may also be used in data communications. One way  
10 to use an optical combiner in data communications is to use it for wavelength division  
11 multiplexing (WDM). As I explained in the declaration I prepared for Opticis  
12 Korea’s IPR petition, WDM technology expanded greatly around the mid-1990s due  
13 to the increased communication needs brought about by, for example, the Internet.  
14 This led to much research and development in optical systems that could be used to  
15 support WDM technology in data communications.

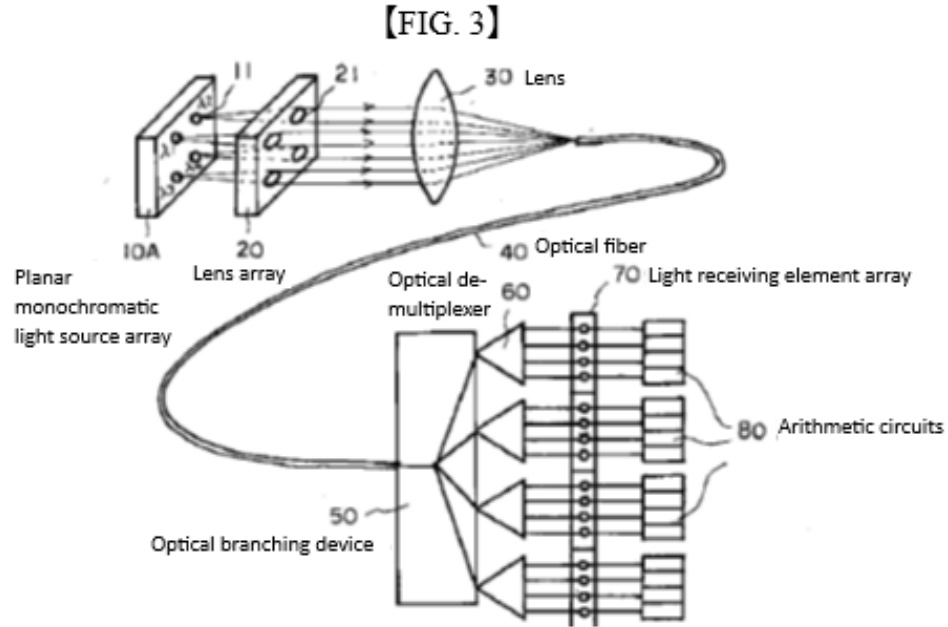
16 35. As an example of using optical combiners in data communications, U.S.  
17 Patent No. 6,870,195 to Lemoff et al. (“Lemoff”) discloses an optical combiner used  
18 in telecommunications and data communications. *See, e.g.*, OpticisKR0003539-48  
19 (“Lemoff”) at 1:8-15 (“In recent years, fiber optic networks that transmit optical  
20 signals have come into widespread use for telecommunications and data  
21 communications. Due to ever-increasing demand for faster data transmission rates,  
22 efforts have been directed to the development of high-capacity optical  
23 communication systems. Such systems typically use one or more optical signals to  
24 convey across an optical transport medium data, applications, content, or other  
25 information, which are collectively termed “information” herein.”), 1:16-25 (“One  
26 technique for increasing the capacity of an optical communications or network  
27 system is to multiplex information from a number of sources. In wavelength division  
28 multiplexing (WDM), a number of channels of information are conveyed on

1 different, non-interfering wavelengths that are transmitted through a single optical  
2 transport medium.”), 1:52-56 (“The invention provides a multi-channel optical signal  
3 emitter for a wavelength division multiplexed (WDM) communication system that  
4 combines multiple signal components into a multi-channel optical signal without  
5 using an optical multiplexer or other device external to the emitter.”).

6 36. Another example of optical combiners used in data communications is  
7 Japanese Patent No. 2,848,279 to Kurita et al. (“Kurita”). *See* OpticisKR003560-74  
8 (“Kurita”). Kurita provides an optical combiner having lasers, collimating lenses,  
9 and a focusing lens that may be used for data communications. *See, e.g.,* Kurita<sup>1</sup>,  
10 ¶[0001] (“The present invention relates to light connection elements and light  
11 connection devices for inputting laser lights into and outputting them out of optical  
12 fibers that are used with multistage switching networks inside optical computers and  
13 switchboards, and with optical communications, laser processing, etc.”), ¶[0002] (“In  
14 the field of wavelength multiplexing optical communications and in the field  
15 requiring high outputs such as laser processing, it may be necessary to couple lights  
16 emitted from plural light sources into a single fiber.”), ¶[0009] (“As the lights emitted  
17 at the light emitting portions of the planar monochromatic light source array are each  
18 collimated at the lens portions of the lens array to be made into parallel beams, and  
19 as the individual beams are converged on one point with the lens to be entered into  
20 one end portion of a single optical fiber, the lights from the individual light emitting  
21 portions entered are multiplexed to become integrated to be transmitted through the  
22 abovementioned single optical fiber.”).

23 37. I am reproducing FIG. 3 of Kurita below.  
24  
25  
26  
27

28 <sup>1</sup> I am quoting from the certified English translation provided in the corresponding  
IPR. *See* IPR2023-01256, Exhibit 1006 (submitted with Paper 1).



Kurita, FIG. 3.

38. Kurita also discloses that the optical combiner it provides has uses outside of data communications. *E.g.*, ¶[0001] (“The present invention relates to light connection elements and light connection devices for inputting laser lights into and outputting them out of optical fibers that are used with multistage switching networks inside optical computers and switchboards, and with optical communications, laser processing, etc.”).

## V. INNEOS’S PATENT-IN-SUIT

39. As mentioned above, I understand that Inneos has asserted the ’416 Patent against Defendants in this case.

40. The ’416 Patent relates to an optical multiplexing device which spatially combines multi-wavelength light from a plurality of lasers into an optical fiber. ’416 Patent, 1:13-16. This portion of my report provides a brief overview of the patent.

41. The ’416 Patent is titled “Optical combiner device,” and was filed on January 27, 2005, and issued on April 3, 2007. The ’416 Patent claims priority to a provisional application filed on February 3, 2004. I also understand that Inneos asserts an earlier priority based on an alleged conception as of July 17, 2003, followed

1 by reduction to practice. The named inventors are Curtis A. Ray, Eric B. Grann, and  
2 Brian C. Peters. The abstract states:

3 An optical device for combining optical signals of different  
4 wavelengths is described wherein an array of laser output beams  
5 are collimated, directed to propagate along a similar path, and  
6 coupled into an optical fiber through a single molded part. The  
7 single-part optical coupling module can be constructed in various  
8 ways to achieve the desired configuration. One example is a single  
9 plastic-injection molded part, containing mechanical alignment  
10 features, an array of collimating lenses, and a focusing lens housed  
11 within a fiber optic connector ferrule. The laser output beams are  
12 separately passed through separate radial sectors of the focusing  
13 lens.

14 '416 Patent, Abstract.

15 **A. Summary of the Patent**

16 42. The '416 Patent "relates to an optical multiplexing device which  
17 spatially combines multi-wavelength light from a plurality of lasers into an optical  
18 fiber." '416 Patent, 1:12-16. By the priority date,<sup>2</sup> wavelength division multiplexing  
19 (WDM) for optical communications was well known. The patent admits as much,  
20 for example, by referring to "prior art wavelength division multiplexed optical  
21 communication systems," which "combine or separate multiple light signals with  
22 varying optical wavelengths." *Id.*, 1:21-42. The patent also refers to "an optical  
23 power combiner which utilizes collimators and a focusing lens to concentrate  
24 multiple output beams," which it admits is "prior art" as disclosed in U.S. Patent No.  
25

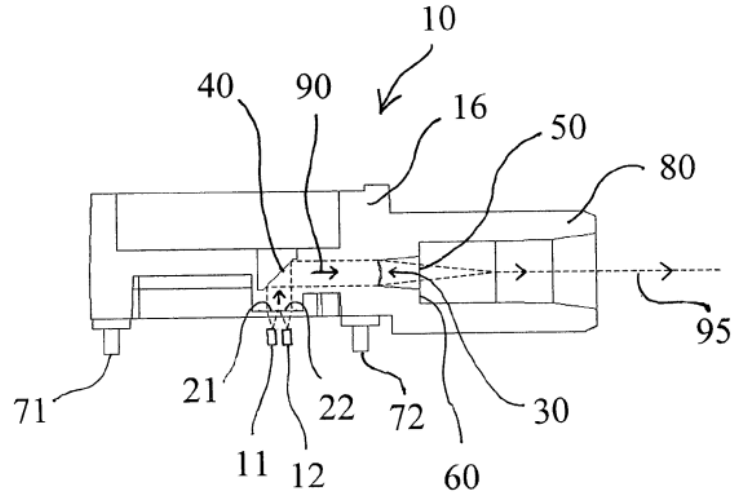
26 <sup>2</sup> I understand that the priority of the '416 Patent is disputed by the parties.  
27 Ultimately, my opinions in this report remain the same regardless of whether the  
28 priority is based on (i) the filing date of the application leading to the '416 Patent,  
(ii) the corresponding provisional application's filing date, or (iii) the conception of  
the invention alleged to take place earlier than this.

1 5,377,278 to Lee et al. *Id.*, 1:56-2:10. Generally speaking, optical combiners,  
2 including optical combiners used for WDM in data communications, were well  
3 known. Optical combiners were also known that had uses outside of data  
4 communications. For a more detailed discussion of this background, see my  
5 summary of the technology background above. See above, Section IV(B)  
6 (Technology Background—Optical Combiners).

7 43. The '416 Patent introduces four embodiments of an optical combiner,  
8 each with various arrangements of components. The first embodiment is shown and  
9 described with respect to FIGS. 1-4. The second embodiment is shown and described  
10 with respect to FIGS. 5-6. The third embodiment is shown and described with respect  
11 to FIGS. 7-9. The fourth embodiment is shown and described with respect to FIGS.  
12 10-11. See generally '416 Patent, 2:45-3:2 (brief description of the drawings), 3:3-  
13 4:53 (detailed description of the invention). I will briefly describe these  
14 embodiments below.

15 44. The first embodiment, shown in FIGS. 1-4, describes combiner 10.  
16 Combiner 10 includes lasers 11, 12 that are located at focal points of collimating  
17 lenses 21-24, and an output focusing lens 30, such that individual light signals are  
18 collimated, travel along optical path 90, are focused and directed towards an optical  
19 fiber. Between the collimating lenses 21-24 and the focusing lens 30 is a  
20 redirectional prism 40 that redirects the light beams by 90°, translating the optical  
21 beams from one axis to another. '416 Patent, 3:7-18.

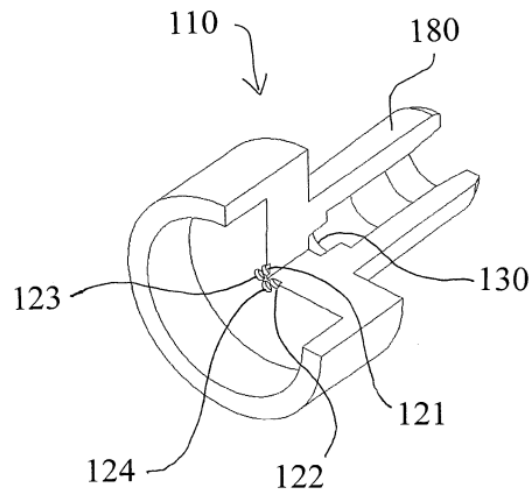
22 45. FIG. 1 (illustrating the first embodiment) is reproduced below:  
23  
24  
25  
26  
27  
28



Also shown here is a ferrule 80, in which a fiber stop or seat 60 is formed, and into which an optical fiber (not shown) may be inserted. *Id.*, 3:11-18.

46. The second embodiment, shown in FIGS. 5-6, describes combiner 110. Combiner 110 differs from combiner 10 in that, for example, it does not have a prism for translating the optical beams from one axis to another. It includes a two-dimensional, two-by-two array of collimating lenses 121-124, a focusing lens 130, and a connector 180 for placing an optical fiber. *Id.*, 3:50-60.

47. FIG. 6 (illustrating the second embodiment) is reproduced below:

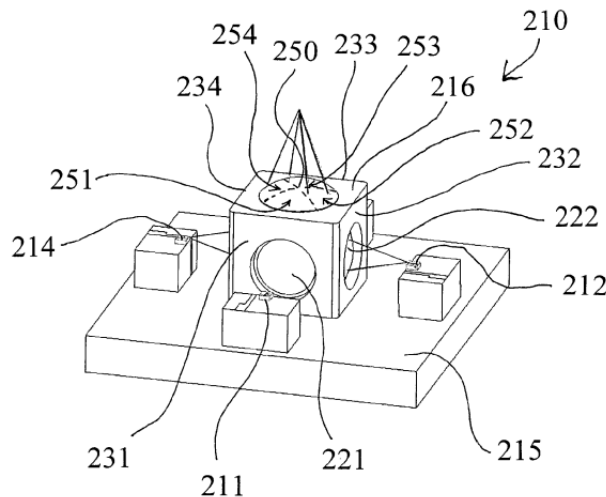


Connector 180 is shown here, and described only as “a fiber connector 180 that allows one to place a fiber optic cable into the pre-aligned connector.” *Id.*, 3:59-60.

1 I note that many types of connectors for optical fibers (or fiber optic cables) were  
2 known, and the '416 Patent does not specify in this embodiment any description of  
3 fiber connector 180, other than that it "allows one to place a fiber optic cable into  
4 the pre-aligned connector."

5 48. The third embodiment, shown in FIGS. 7-9, describes combiner 210.  
6 Combiner 210 has a circular array of four lasers 211-214, which are positioned  
7 around four collimating lenses 221-224. Combiner 210 also has a focusing lens 250.  
8 *Id.*, 3:61-4:9. The collimating lenses 221-224 and focusing lens 250 are arranged in  
9 a coupling optic 216 formed of a single monolithic molded block.

10 49. FIG. 7 (illustrating the third embodiment) is reproduced below:

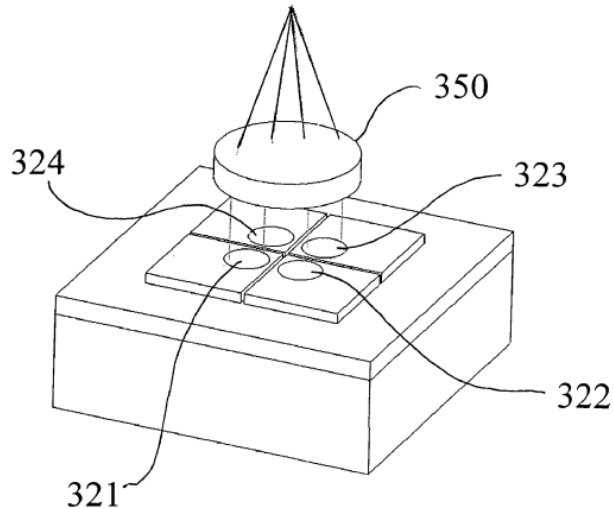


19 There are also prisms for redirecting the light (shown as 242, 244 in FIG. 8). *Id.*,  
20 4:11-19. No connector is shown or described with respect to the third embodiment.  
21 While the patent references a "stopped single fiber optic" when describing this  
22 embodiment (*id.*, 4:24), it does not describe in this embodiment how the optical  
23 fiber is to be stopped or otherwise describe a connector for inserting the optical  
24 fiber into.

25 50. The fourth embodiment, shown in FIGS. 10-11, describes combiner  
26 310. Combiner 310 differs from the third embodiment, for example, in that it (like  
27 the second embodiment) does not have a prism for translating the optical beam from  
28

one axis to another. Combiner 310 also includes a separately molded focusing lens 350 and separately molded collimating lenses 321-324.

51. FIG. 11 (illustrating the fourth embodiment) is reproduced below:



No connector is shown or described with respect to the fourth embodiment.

52. The components and arrangements vary between the four embodiments. Common to the embodiments, however, is that a focusing lens (e.g., lens 30, 130, 250, 350) is used to focus the collimated light beams onto a single spot.

53. The '416 Patent also explains that there are various “[p]otential [a]pplications” of the disclosed optical combiner. These applications include: “(1) Wavelength division multiplexing/demultiplexing (WDM)”; “(2) Optical signal routing”; “(3) Spectroscopy”; “(4) Biological and chemical integrated optical sensors”; and “(5) Optical computing.” *Id.*, 5:4-10. This is consistent with my discussion above, describing the technology background, of the different applications to which optical combiners may be put. *See above*, Section IV(B) (Technology Background—Optical Combiners).

## **B. Prosecution History**

54. I have reviewed the prosecution history. During prosecution, the Patent Office rejected the claims as anticipated over a prior art reference. Rather than argue

1 over the reference, the applicant swore behind it, asserting that its invention was  
2 entitled to an earlier priority date.

3 55. The Patent Office rejected the claims in an office action dated October  
4 5, 2005. In particular, claims 1, 2, 6, 7, and 9 were rejected as anticipated under 35  
5 U.S.C. § 102(e) over U.S. Patent Publication No. 2005/0069013 to Bhandarkar et al.  
6 Claims 3-5 and 8 were indicated as containing allowable subject matter. The Patent  
7 Office also made U.S. Patent No. 6,219,476 to Kususawa et al. of record as it was  
8 “considered pertinent to applicant’s disclosure,” although it was not relied upon. *See*  
9 Dkt. 69-2, pp. 36-41.

10 56. Applicant filed a response dated April 4, 2006. Applicant amended the  
11 claims, adding “usable in data communication systems” to the preamble, and adding  
12 “said n laser output beams have n different output wavelengths” (already in the  
13 preamble) to the claim’s body, for both independent claims 1 and 7 (with minor  
14 differences for claim 7, which does not use the variable “n”). In remarks, Applicant  
15 submitted declarations asserting an earlier conception date to swear behind the  
16 Bhandarkar reference. Applicant also remarked on the Kususawa reference, which  
17 was not relied upon but was made of record, that it had no teaching or suggestion “of  
18 multiplexing a plurality of laser output beams having different wavelengths for use  
19 in data communications....” Dkt. 69-2, p.51. Applicant pointed specifically to the  
20 requirement that the n laser output beams have n different output wavelengths and  
21 the focusing means has n separate radial sectors on its surface for refracting each of  
22 the separate laser output beams through the same angle as it passes through the  
23 focusing means. *See* Dkt. 69-2, pp. 47-112.

24 57. The Patent Office then issued a final rejection of the claims in an office  
25 action dated July 5, 2006. The Patent Office noted deficiencies in the declarations  
26 and therefore maintained the rejection over Bhandarkar. *See* Dkt. 69-2, pp. 114-121.

27 58. Applicant filed a response dated December 5, 2006. Applicant amended  
28 the claims, adding “whereby said n output beams having n different wavelengths are

1 coupled into said single fiber” and deleting “and each of said n collimated beams is  
2 refracted through the same angle as it passes through said focusing means” to the  
3 claim’s body, for both independent claims 1 and 7 (with adjustments to claim 7,  
4 which does not use the variable “n”, and also changing the radial “sectors” in claim  
5 7 to “quadrants”). Applicant noted that it had deleted “and each of said n collimated  
6 beams is refracted through the same angle as it passes through said focusing means”  
7 in response to the Patent Office’s concern that there was no evidence of conception  
8 as to this limitation, and otherwise responded to the Patent Office’s other remarks  
9 regarding the swear-behind declarations. *See* Dkt. 69-2, pp. 126-146.

10 59. A Notice of Allowance was mailed on January 8, 2007. *See* Dkt. 69-2,  
11 pp. 153-159. The ’416 Patent issued soon after, on April 3, 2007.

## 12 VI. LEGAL STANDARDS

13 60. I am not an attorney. I have been informed about the legal standards for  
14 patent claim construction by counsel for Opticis Korea.

### 15 A. Claim Construction

16 61. I understand that the primary focus in determining the meaning of a  
17 claim limitation is to consider the intrinsic evidence of record, which includes the  
18 claims, the specification, and the prosecution history, from the perspective of a  
19 POSITA. I understand that claims must be adequately grounded in the specification  
20 and the meaning of claim terms must be discerned in the context of the disclosed  
21 invention and in the field of art.

22 62. I further understand that extrinsic evidence, which includes information  
23 external to the patent’s claims, specification, and prosecution history, such as expert  
24 and inventor testimony, dictionaries, and textbooks, may also be considered, but may  
25 not be used to contradict or override the intrinsic evidence.

26 63. I also understand that the words used in a claim are generally given their  
27 plain and ordinary meaning as understood by a POSITA in question at the time of the  
28 invention. If a disputed term has no previous meaning to those of ordinary skill in

1 the art, the meaning must be found elsewhere in the patent, including the meaning  
2 given by the term's usage in the specification.

3 **B. "Means-Plus-Function" Claims**

4 64. I have been informed that a somewhat different claim construction  
5 analysis applies with respect to means-plus-function claim elements. As to such  
6 claim elements, I am informed that a claim element can be expressed in a manner  
7 that recites a means or step for performing a specified function without the recital of  
8 structure, material, or acts in support thereof. I am further informed that, for such a  
9 claim, the claim is to be construed to cover the structure, material, or acts described  
10 in the patent specification for performing the recited function and equivalents thereof.  
11 Thus, in construing such claims, one must consult the patent specification in order to  
12 determine the relevant structures for performing the recited function.

13 65. Therefore, I am informed that one must first determine whether an  
14 asserted claim element invokes the means-plus-function framework. I further  
15 understand that if the word "means" appears in a claim element in association with a  
16 function, one should presume that such claim element is a means-plus-function  
17 element.

18 66. To summarize, I am informed and understand that to construe claim  
19 elements identified as means-plus-function elements, one must: a) identify the  
20 function of the element; b) identify the structure, material and/or acts in the patent  
21 specification corresponding with the function; and c) define the claim element to  
22 mean the structures, materials and/or acts disclosed in the patent specification and  
23 their structural equivalents.

24 **C. Indefiniteness**

25 67. I have been informed that, under current law, to establish indefiniteness  
26 of a patent claim, it must be established by clear and convincing evidence that the  
27 claim as a whole, read in light of the patent's specification and prosecution history,  
28 fails to inform, with reasonable certainty, those skilled in the art about the scope of

1 the invention. I have been informed that indefiniteness is evaluated from the  
2 perspective of a person of ordinary skill in the art at the time of the claimed invention.  
3 Further, I have been informed that it is not sufficient that a claim term can be ascribed  
4 some meaning. I have also been informed that a claim term does not render a claim  
5 indefinite merely because it is broad; that is, that the breadth of a claim is distinct  
6 from whether or not the claim is indefinite.

7 **D. Definition of Person of Ordinary Skill in the Art**

8 68. I am informed and understand that my interpretation and analysis of the  
9 patent and claims must be undertaken from the perspective of a hypothetical “person  
10 of ordinary skill in the art” (referred to as a POSITA). The “art” is the field of  
11 technology to which the patent is related. The field relevant to the inventions of the  
12 patent-in-suit is optical multiplexing devices.

13 69. In my opinion, a person of ordinary skill in the relevant field as of any  
14 of the possible priority dates (whether July 17, 2003 as asserted by Plaintiff, the  
15 provisional date of February 4, 2004, or the non-provisional filing date of January  
16 27, 2005) of the patent-in-suit would have had: at least a bachelor’s degree in  
17 electrical engineering, physics, or a related field, and at least 2 years of practical  
18 experience in optical technologies. These descriptions are approximate, and a higher  
19 level of education or skill might compensate for less experience, and vice-versa.

20 70. In determining who would be a person of ordinary skill, I considered at  
21 least the following criteria: (a) the type of problems encountered in the art; (b) prior  
22 art solutions to those problems; (c) the rapidity with which innovations are made; (d)  
23 the sophistication of the technology; and (e) the education level of active workers in  
24 the field.

25 71. I have both a Ph.D. and ~35 years of experience in industry and  
26 academia (see Appendix A), and I am well acquainted with the level of ordinary skill  
27 that would be required to implement the optical devices described in the ’416 Patent.  
28 I am also capable of rendering informed opinions as to the understanding of a

1 POSITA as of the time of the alleged invention, including the meaning of terms found  
2 in the asserted claims.

3 72. I am qualified as a POSITA, both now and as of the time of the  
4 invention.

5 **VII. THE UNDERSTANDING OF ONE OF ORDINARY SKILL IN THE**  
6 **ART WITH REGARD TO CERTAIN CLAIM TERMS**

7 73. I have reviewed the '416 Patent and its prosecution history, and have  
8 analyzed the meanings of the claim terms as of the time of the alleged invention. I  
9 reserve the right to revise my opinion if a different date of invention is proven.

10 74. My opinion with respect to each of the terms, phrases, and clauses in  
11 dispute between the parties is set forth below. I list the proposed constructions and  
12 my opinions concerning each, including the intrinsic and, if appropriate, extrinsic  
13 evidence that I have relied on.

14 **A. Term 1: Whether the Preambles are Limiting**

| Plaintiff's Proposed Construction | Opticis Korea's Proposed Construction |
|-----------------------------------|---------------------------------------|
| The preamble is limiting.         | The preamble is not limiting.         |

17  
18 75. The body of each of the independent claims defines a structurally  
19 complete invention. For example, independent claim 1 is reproduced below:

20 1. An optical combiner usable in data communication systems  
21 for multiplexing the outputs of a plurality of n lasers wherein each of  
22 said n outputs has a different output wavelength, for transmission into  
23 and through a stopped single optical fiber, comprising:

24 a plurality of n collimating lenses, said lenses being spaced  
25 apart and positioned to receive and collimate the output of said n laser  
26 output beams, said n laser output beams have n different output  
27 wavelengths, and

28 focusing means for focusing said n collimated output beams

1 onto a single spot at said stopped single optical fiber, said focusing  
2 means having n separate radial sectors on its surface, and each of said  
3 n collimated beams passes through a separate one of said n sectors of  
4 said focusing means whereby said n output beams having n different  
5 wavelengths are coupled into said single fiber.

6 '416 Patent, claim 1.

7 76. Similarly, independent claim 7 is reproduced below:

8 7. An optical combiner usable in data communication systems  
9 for multiplexing the outputs of a plurality of lasers wherein each of  
10 said outputs has a different wavelength, for transmission into and  
11 through a stopped single optical fiber, comprising:

12 an array of four lasers, formed in a two-dimensional, two by  
13 two array, each of said lasers having an output beam with a different  
14 wavelength,

15 an array of four collimating lenses, said lenses being formed in  
16 a two-dimensional, two by two array and positioned to receive and  
17 collimate the output of said laser output beams, and

18 focusing means for focusing said collimated output beams onto  
19 a single spot at said stopped single optical fiber, said focusing means  
20 having four separate quadrants on its surface, and each of said four  
21 collimated beams passes through a separate one of said quadrants of  
22 said focusing means whereby said output beams of said four lasers are  
23 coupled into said single fiber.

24 '416 Patent, claim 7.

25 77. As is shown above, the body of the claims describes the particular  
26 arrangement of (i) collimating lenses and (ii) focusing means (i.e., a focusing lens)  
27 that form the claimed optical combiner. (Claim 7 also includes an array of four lasers  
28 as part of the optical combiner.) The preamble states that the optical combiner is

1 “usable in data communication systems for multiplexing the outputs of a plurality of  
2 n lasers wherein each of said n outputs has a different output wavelength, *for*  
3 transmission into and through a stopped single optical fiber.” Claim 1 (emphasis  
4 added); *see also* Claim 7 (similar). This, however, is merely a purpose or intended  
5 use of the optical combiner. That the combiner is usable in data communication  
6 systems in the manner provided in the claims does not suggest that the underlying  
7 structure of the optical combiner is changed. Nor does the specification indicate it  
8 is, nor would a POSITA understand the structure to be different based on the claim  
9 language in view of the specification.

10 78. The ’416 Patent itself also explains that claimed optical combiner may  
11 be used in a variety of ways. Among the numerous “Potential Applications” of the  
12 invention are: “1) Wavelength division multiplexing/demultiplexing (WDM),” “2)  
13 Optical signal routing,” “3) Spectroscopy,” “4) Biological and chemical integrated  
14 optical sensors,” and “5) Optical computing.” ’416 Patent, 5:4-10. In other words,  
15 the inventors readily state that the claimed optical combiner has many possible uses,  
16 and the purpose or intended use stated in the preambles would not limit the way a  
17 POSITA would understand the structure of the optical combiner.

18 79. This is also consistent with other evidence. For example, nothing in the  
19 prosecution history suggests that the Applicant considered the preamble to be  
20 limiting or to have a narrow meaning. For example, as explained above, the  
21 Applicant amended the claims during prosecution to require *in the body of the claims*  
22 that “said n laser output beams have n different output wavelengths” despite a similar  
23 requirement already having appeared in the preamble (namely, “said n outputs has a  
24 different output wavelength”). *See above*, Section V(B) (Prosecution History). If  
25 the preamble were limiting, this amendment would have been unnecessary. This  
26 strongly indicates to a POSITA at least that the Applicant did not regard the preamble  
27 as limiting. As additional evidence, it is and, as of the time of the invention, was well  
28 known that optical combiners could be used for a variety of purposes. *See above*,

Section IV(B) (Technology Background—Optical Combiners). Prior art references demonstrate that known optical combiners, including those with the same or substantially similar structure as claimed, could be used for applications other than “data communication systems for multiplexing the outputs of a plurality of n lasers wherein each of said n outputs has a different output wavelength, for transmission into and through a stopped single optical fiber.” For example, U.S. Patent No. 5,715,270 to Zediker et al. [OpticisKR0003524] (“Zediker”) demonstrates an optical combiner having the same or similar structure that may be used for other purposes.

80. For example, as described above, among other prior art, Zediker describes an optical combiner that has many purposes different from data communication systems for multiplexing the outputs of a plurality of n lasers wherein each of said n outputs has a different output wavelength, for transmission into and through a stopped single optical fiber. See above, Section IV(B) (Technology Background—Optical Combiners).

**B. Term 2: “Optical Combiner”**

| Plaintiff’s Proposed Construction                                                                                                                                                            | Opticis Korea’s Proposed Construction                |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|
| “an integrated subassembly of optical components for multiplexing light of different wavelengths, which includes a pre-aligned connector with a stop to hold the single fiber optical cable” | plain and ordinary meaning (if preamble is limiting) |

81. The term “optical combiner” appears in the preamble of the claims. Independent claims 1 and 7 both recite “[a]n optical combiner ... comprising” various elements. For the reasons discussed above with respect to Term 1, the preamble is not limiting. However, to the extent that it is determined that this particular portion of the preamble is a limitation of the claims, it should be given its plain an ordinary meaning.

1           82. The plain and ordinary meaning of an “optical combiner” is *a device*  
2 *that combines multiple optical inputs into an output*. This is, after all, the meaning  
3 of “combine,” and the point of a “combiner” is that it “combines” multiple inputs  
4 into an output. In the case of an optical combiner, it is multiple optical inputs that  
5 are combined into an output.

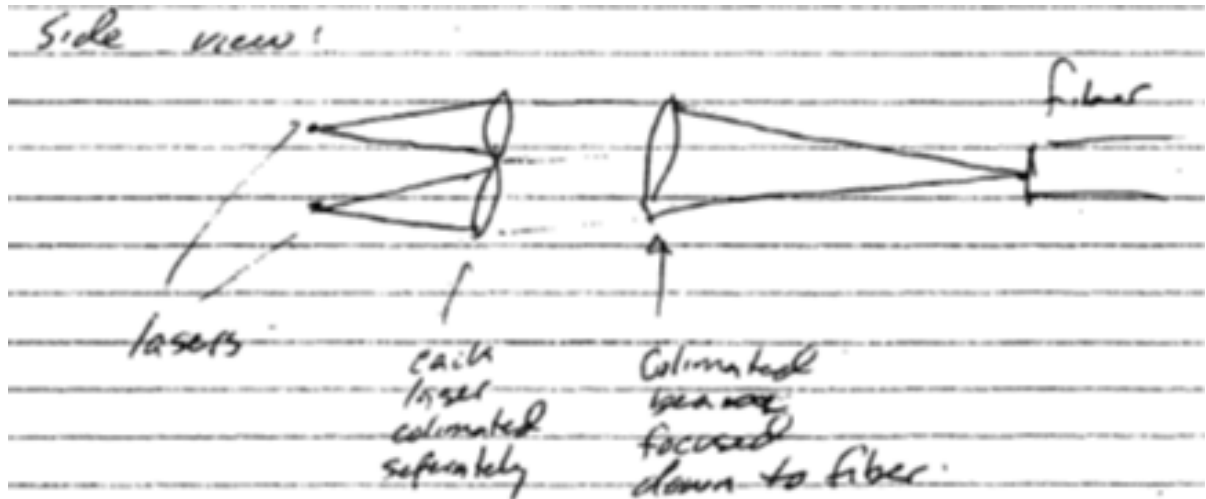
6           83. This is consistent with how the ’416 Patent uses the term. ’416 Patent,  
7 3:19-21 (“This combiner device has the ability to combine individual light signals  
8 into an optical path 90 that can be directed towards an optical fiber (not shown for  
9 clarity.)”); *id.*, 1:56-62 (“The prior art also includes an optical power combiner which  
10 utilizes collimators and a focusing lens to concentrate multiple output beams to  
11 increase power density; see Lee et al U.S. Pat. No. 5,377,287. The Lee et al device  
12 combines the outputs of, for example, 19 passive optical fibers arranged  
13 concentrically together with 19 collimating lenses and a Fresnel focusing lens.”).

14           84. Turning to the prosecution history, I am not aware of anything there  
15 indicating that the Applicant had a special definition or understanding of the term, or  
16 that the Applicant had disavowed the normal meaning of this term – or even that the  
17 Applicant had considered the phrase, in the claim preamble, to be limiting at all.

18           85. First, the Applicant amended the claims to require that “said n laser  
19 output beams have n different output wavelengths,” and argued this requirement was  
20 “[i]n contrast to” a prior art reference. See Dkt.69-2, pp. 48-49 (amending claims),  
21 51-52 (arguing over prior art cited by examiner but not relied on for a rejection)  
22 (Response of Oct. 5, 2005); see also above, Section V(B) (Prosecution History). In  
23 so doing, Applicant did not rely on the preamble, or the term “optical combiner”  
24 necessarily connoting output beams of different wavelength; instead, Applicant  
25 chose to amend the claim’s body to require this.

26           86. Second, in the same response, Applicant swore behind another prior art  
27 reference. In doing so, Applicant pointed to inventor declarations and notebooks that  
28 described the “concept” of the invention without referencing an integrated, pre-

1 aligned connector having a stop. *Id.*, p. 50 (referring to declaration of inventor Curtis  
2 A. Ray), p. 54 (indicating the “concept” of the invention is recorded at p. 16 of his  
3 lab notebook), p. 58 (p. 16 of lab notebook illustrating concept). The inventor’s  
4 illustration is reproduced below:



14 Dkt. 69-2, p. 58.

15 87. Had Applicant considered “optical combiner” to be limiting and to have  
16 the meaning now ascribed by Inneos to it, Applicant should have pointed to the  
17 conception of these ideas. That it did not do so indicates the Applicant did not  
18 consider either that the preamble was limiting, or that “optical combiner” had the  
19 narrow meaning Inneos now gives it.

20 88. Additionally, the Applicant submitted a number of drafts of the  
21 provisional patent application to support its swear-behind attempt. The first draft  
22 provided appears at Dkt. 69-2, pp. 63-73, the second draft (with redlining) appears at  
23 pp. 74-84, the third draft appears at pp. 85-95. These drafts also are consistent with  
24 an understanding of optical combiner as a device that combines multiple optical  
25 inputs into an output. For example, the first draft indicated that “this invention relates  
26 to an optical multiplexing device which spatially combines multi-wavelength light  
27 from a plurality of lasers into an optical fiber.” Dkt. 69-2, p. 64. The second draft  
28 added the sentence, “Most combiner devices are used as wavelength division

1 multiplexers,” indicating that not all combiner devices are so used. *Id.*, p. 74. It also  
2 indicated that the multiplexing device described in the disclosure is a combiner. *Id.*  
3 (*e.g.*, changing title and referring to “The combiner/WDM device described herein”).  
4 The third draft is also consistent with this. *Id.*, p. 85.

5 89. The understanding of “optical combiner” as a device that combines  
6 multiple optical inputs into an output is also consistent with how others in the field  
7 understand the term. For example, the following references show a consistent  
8 understanding of “optical combiner” as a device that combines multiple optical inputs  
9 into an output:

- 10 • G. L. Li, and P. K. L. Yu, Optical Intensity Modulators for Digital and Analog  
11 Applications in JOURNAL OF LIGHTWAVE TECHNOLOGY, VOL. 21,  
12 NO. 9, SEPTEMBER 2003 [OpticisKR0007166-86]: Two optical beams, each  
13 in one of two waveguiding arms of an optical interferometer, are combined  
14 into an output by an optical combiner.
- 15 • Glen Kramer and Gerry Pesavento, Ethernet Passive Optical Network  
16 (EPON): Building a Next-Generation Optical Access Network  
17 [OpticisKR0007152-59]: In the upstream direction of a passive optical  
18 network, an optical combiner combines different optical beams from multiple  
19 inputs into an output.
- 20 • Rodney S. Tucker and Steven K. Korotky, Optical Time-Division  
21 Multiplexing For Very High Bit-Rate Transmission in JOURNAL OF  
22 LIGHTWAVE TECHNOLOGY, VOL h, NO, II, NOVEMBER 19RR 1737  
23 [OpticisKR0007187-99]: An optical combiner combines different trains of  
24 light pulses each on a different input optical path into an output.
- 25 • Koji Kudo, et al., 1.55- $\mu$ m Wavelength-Selectable Microarray DFB-LD’s with  
26 Monolithically Integrated MMI Combiner, SOA, and EA-Modulator in IEEE  
27  
28

1 PHOTONICS TECHNOLOGY LETTERS, VOL. 12, NO. 3, MARCH 2000  
2 [OpticisKR0007119-21]: A multimode-interference combiner combines the  
3 optical beams of multiple different lasers into an optical output.

4  
5 90. I understand that Inneos is proposing to construe the term “optical  
6 combiner” as meaning “[i] an integrated subassembly of optical components [ii] for  
7 multiplexing light of different wavelengths, [iii] which includes an integrated, [iv]  
8 pre-aligned connector [iv] with a stop to hold the single fiber optic cable” (bracketing  
9 added). This goes beyond how the term is ordinarily used in the art. As the term is  
10 used in the art, all an optical combiner must do is combine multiple optical inputs  
11 into an output. Each of the bracketed requirements above, in Inneos’s proposed  
12 construction, is not ordinarily understood as a requirement of an “optical combiner.”

13 91. For example, an optical combiner:

- 14 (i) Does not need “an integrated subassembly of optical components.” Even  
15 the ’416 Patent acknowledges this, as it provides for one embodiment  
16 where the optical components are integrated into a plastic molded coupling  
17 module 16, and another embodiment where there is not a single coupling  
18 module which integrates the optical components. ’416 Patent, 3:39-44  
19 (describing integration in first embodiment), 4:35-53 (describing separately  
20 molded collimating lenses and separately molded focusing lens in fourth  
21 embodiment). *See also id.*, 4:60-63 (“Monolithic Coupling Optics[:] Each  
22 optical coupling and redirection component is integrated within a single  
23 monolithic plastic-molded device in *most embodiments.*”) (emphasis  
24 added).
- 25 (ii) Does not have to be “for multiplexing light of different wavelengths.”  
26 Indeed, the patent expressly acknowledges this. ’416 Patent, 2:5-7 (“[T]he  
27 Lee et al [optical] combiner does not multiplex n different wavelength  
28 channels[.]”).

- 1 (iii) Does not need to “include[] an integrated ... connector.”
- 2 (iv) Does not need a connector that is “pre-aligned.”
- 3 (v) Does not need the connector to have “a stop to hold the single fiber optic
- 4 cable.” There are a variety of known connectors for fiber optic cables.
- 5 Some of these may include a “stop” as illustrated by the fiber stop or seat
- 6 60 in the ’416 Patent, and some may not, depending on their design.
- 7 Indeed, “stop” is not a common term of art in this field. To the extent
- 8 Inneos means only the fiber stop or seat 60 shown in the drawings of the
- 9 patent for one of the embodiments, other ways of fixing a single fiber optic
- 10 cable were well known, and applicable to optical combiners.

11 92. These limitations, which Inneos proposes as part of “optical combiner,”  
12 are imported from embodiments in the specification. They also differ from how the  
13 term “optical combiner” is customarily used and how it is used within the ’416 Patent.

14 93. The ’416 Patent describes prior art optical combiners not encompassed  
15 by Inneos’s proposed construction. At least some prior art optical combiners did not  
16 necessarily multiplex light of different wavelengths. ’416 Patent, 2:5-7 (indicating  
17 that the Lee et al. optical combiner does not multiplex light of different wavelengths).  
18 Moreover, the claims elsewhere specify that “said n laser output beams have n  
19 different output wavelengths,” and also refer to “multiplexing,” which would not be  
20 necessary if the patent had considered these concepts encompassed by the term  
21 “optical combiner.” Additionally, while the patent explains that “[t]he combiner 10  
22 in this [first] embodiment includes” a “fiber stop or seat 60 formed in a ferrule 80”  
23 and refers to a “pre-aligned connector,” other embodiments do not illustrate or  
24 describe such a stop or a pre-aligned connector. See ’416 Patent, 3:8-17 (first  
25 embodiment); *id.*, 4:35-52 (describing fourth embodiment without referring to a  
26 “stop” or a “pre-aligned connector”), FIGS. 9-10 (illustrating fourth embodiment  
27 without showing a “stop” or a “pre-aligned connector”). Even if the fourth  
28 embodiment could include a stop or a pre-aligned connector, nothing in the patent

indicates it is required, let alone that the term “optical combiner” necessarily is limited to this structure. This shows that there is no redefinition of the term or clear and unmistakable disavowal of claim scope.

**C. Term 3: “focusing means for focusing said n collimated output beams onto a single spot at said stopped single optical fiber” (claim 1) / “focusing means for focusing said collimated output beams onto a single spot at said stopped single optical fiber” (claim 7)**

| Plaintiff’s Proposed Construction                                                                                                                 | Opticis Korea’s Proposed Construction |
|---------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| Structure: “lens integrated into the optical combiner that is in alignment with the collimating lenses and the core of the stopped optical fiber” | Structure: “focusing lens”            |

94. I have been informed that the parties agree this term is a means-plus-function limitation, and that the function is “focusing said [n] collimated output beams onto a single spot at said stopped single optical fiber.” I have also been informed that to qualify as corresponding structure identified in the specification, the structure must not only perform the claimed function, but the specification must clearly associate the structure with performance of the function.

95. Looking at what the specification clearly associates with the agreed on function, the only structure the specification identifies is a focusing lens. That is, the *structure* of a focusing lens is what performs the *function* of “focusing said [n] collimated output beams onto a single spot at said stopped single optical fiber.” The ’416 Patent states that “the [laser] light is collimated, reflected off a prism 40 and *focused by the focusing lens 30* onto a spot at which a single optical fiber (not shown) is stopped by fiber stop or seat 60 formed in ferrule 80.” ’416 Patent, 3:11-15 (emphasis added); *see also id.*, 3:34-38 (stating that the combiner includes “*lens 30 for focusing* several geometrically placed collimated beams onto the output fiber (not

1 shown)”) (emphasis added); *id.*, 2:65-67 (“The present invention, in contrast, uses a  
2 separate radial sector of the *focusing lens to focus* each separate laser output.”)  
3 (emphasis added). Where it is described, it is the focusing lens that performs the  
4 function of “focusing,” and specifically, it is the focusing lens that focusses the  
5 collimated beams onto a single spot at the stopped single optical fiber. No other  
6 structure is identified anywhere in the specification that focuses the output beams  
7 onto a single spot at said stopped single optical fiber.

8 96. The claims are also illustrative of the structure. Claim 2, which depends  
9 from claim 1, recites that “said focusing means *is a single focusing lens.*” Claim 2  
10 does not say the focusing lens is integrated or aligned in any particular way.

11 97. Moreover, the specification does not clearly associate either the lens  
12 being “integrated into the optical combiner” or a lens “that is in alignment with the  
13 collimating lenses and the core of the stopped optical fiber” as the structure that  
14 performs the function of the focusing means.

15 98. With respect to “integrated into the optical combiner”, the patent refers  
16 to a specific embodiment where a “plastic molded coupling module 16 is formed by  
17 integrating” multiple components, including focusing lens 30, “all within a single  
18 part 16.” *Id.*, 3:39-44. This refers to a specific embodiment where “[e]ach optical  
19 coupling and redirection component is integrated within a single monolithic plastic-  
20 molded device.” *Id.*, 4:61-63; *see also* claim 3 (requiring that “said collimating  
21 lenses, said prism and said focusing lens are formed as a single, monolithic molded  
22 block”). Nothing in the description of the multiple components being integrated  
23 within a single monolithic plastic-molded device clearly associates integrating with  
24 the function of the focusing means. In fact, other than merely mentioning “a focusing  
25 lens 30” as one of the many components that are integrated into the plastic molded  
26 coupling optic 16 in the first embodiment, the patent does not mention focusing when  
27 describing this optional integration, let alone clearly associate it with the claimed  
28

1 function of “focusing said [n] collimated output beams onto a single spot at said  
2 stopped single optical fiber.”

3 99. The fact that claim 3, which depends from claim 1, requires this  
4 integration also undermines the suggestion that the focusing means of claim 1 also  
5 requires it. I understand, for example, that dependent claims are generally narrower  
6 than the independent claim from which they depend. Also, other embodiments do  
7 not require integration. The fourth embodiment (shown in FIGS. 10-11), for  
8 example, illustrates a lens 350 which is formed separately from the collimating lenses  
9 321-324. The patent does not describe the lens 350 as “integrated;” it notes, simply,  
10 that “focusing lens 350 is supported in its position shown in FIG. 10 by means known  
11 to those skilled in the art which are deleted in the interest of brevity.” ’416 Patent,  
12 4:43-45. The “means known to those skilled in the art” could include a wide variety  
13 of ways to support the position of focusing lens 350, and does not require integration.  
14 Indeed, the specification distinguishes the integration of the first embodiment (a “one  
15 piece” optical combiner”) with the “separately molded” lenses of the fourth  
16 embodiment (a “two piece” optical combiner). ’416 Patent, 2:11-20, 3:32-38, 4:35-  
17 39.

18 100. With respect to “that is in alignment with the collimating lenses and the  
19 core of the stopped optical fiber”, the patent explains among a list of multiple objects  
20 of the invention that one object is “to passively align an optical fiber to the coupling  
21 optic” by “integrat[ing] a fiber optic connector within the optical module.” ’416  
22 Patent, 2:38-40. The patent explains that “[a]ll of the optical components within the  
23 multiplexer could utilize passive alignment mechanisms.” *Id.*, 4:58-59. That optical  
24 components “could” (but need not) utilize passive alignment, or even that passive  
25 alignment is one of many non-limiting objects of the invention, does not clearly  
26 associate aligning with the function of the focusing means. Indeed, the specification  
27 does not describe focusing when discussing the optional alignment features, let alone  
28

clearly associate such alignment with the claimed function of “focusing said [n] collimated output beams onto a single spot at said stopped single optical fiber.”

**D. Term 4: “stopped” / “stopped single optical fiber”**

| Plaintiff’s Proposed Construction                                                                                                                                                                                                                                                                                          | Opticis Korea’s Proposed Construction |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| <p>“Abutting a physical structure that prevents the fiber from being inserted further into the optical combiner” //</p> <p>“A single optical fiber that has been inserted into the optical combiner until it abuts a physical structure that prevents the fiber from being inserted further into the optical combiner”</p> | <p>stopped means “fixed”</p>          |

101. The term “stopped” is found in claims 1 and 7, as highlighted in the following excerpts from the claims:

Claim 1: “multiplexing the outputs of a plurality of n lasers wherein each of said n outputs has a different output wavelength, for transmission into and through a *stopped* single optical fiber” and “focusing means for focusing said n collimated output beams onto a single spot at said *stopped* single optical fiber”

Claim 7: “multiplexing the outputs of a plurality of lasers wherein each of said outputs has a different wavelength, for transmission into and through a *stopped* single optical fiber” and “focusing means for focusing said collimated output beams onto a single spot at said *stopped* single optical fiber.”

As I explain in detail below, a POSITA would have understood this term to mean “fixed” in the context of the ’416 Patent.

102. As an initial matter, the term “stopped” is not typically used to describe optical fibers in this field, including with respect to either transmission into a fiber or

1 the focusing of beams onto a fiber. As such, and in my opinion, “stopped” does not  
2 have a plain and ordinary meaning as understood by a POSITA at the time of the  
3 invention. Therefore, I have been asked to consider the meaning of the term stopped  
4 in the context of the specification and claims of the ’416 Patent.<sup>3</sup>

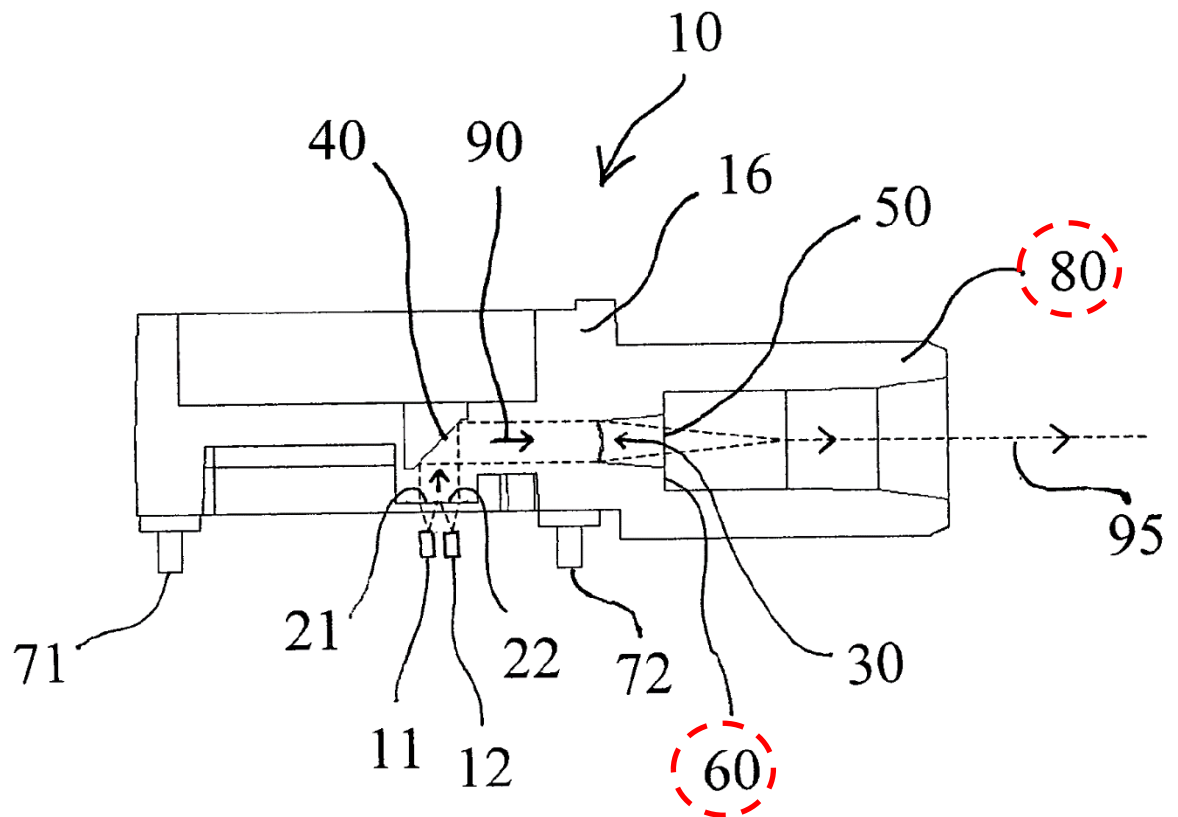
5 103. Starting with the claim language itself, the claims refer to “transmission  
6 into and through a *stopped* single optical fiber” and “focusing ... collimated output  
7 beams onto a single spot at said *stopped* single optical fiber.” See claims 1 and 7  
8 (emphasis added). In both cases – transmission into/through and focusing onto a  
9 single spot – it would be clear to a POSITA that the single optical fiber would need  
10 to be fixed in place. An optical fiber being spatially fixed was well known to be  
11 important in optical systems since light needed to be coupled into a very small  
12 waveguiding fiber core, and any non-negligible movement could cause significant  
13 optical power loss and performance degradation. A “stopped” single optical fiber  
14 would not be free or otherwise able to significantly move about.

15 104. This is consistent with the use of the term in the specification text and  
16 drawings of the ’416 Patent for at least two reasons.

17 105. First, the specification describes “a single optical fiber (not shown)” that  
18 is “stopped by fiber stop or seat 60 formed in ferrule 80.” ’416 Patent, 3:13-15; see  
19 *also id.* at 3:23-24 (“the fiber (not shown) inserted into ferrule 80, seated at the fiber  
20 stop 60”) and FIG. 1:

---

28 <sup>3</sup> The term does not appear to have been addressed during prosecution.



(annotations added). A seat and ferrule arrangement is (and was in 2003 before the earliest possible priority date of the '416 Patent) a common way to fix an optical fiber in place. *See, e.g.,* Lemoff at 5:58-20 (“During assembly, the end of optical fiber 250 is inserted into ferrule 255, which surrounds and secures the end of the fiber.”). In the example above, the fiber would be inserted into the ferrule 80, abutting against seat 60, and thus held in place – lateral movement constrained by the ferrule 80 and longitudinal movement limited by the seat 60.

106. Second, the specification discusses the “stopped” fiber in connection with alignment:

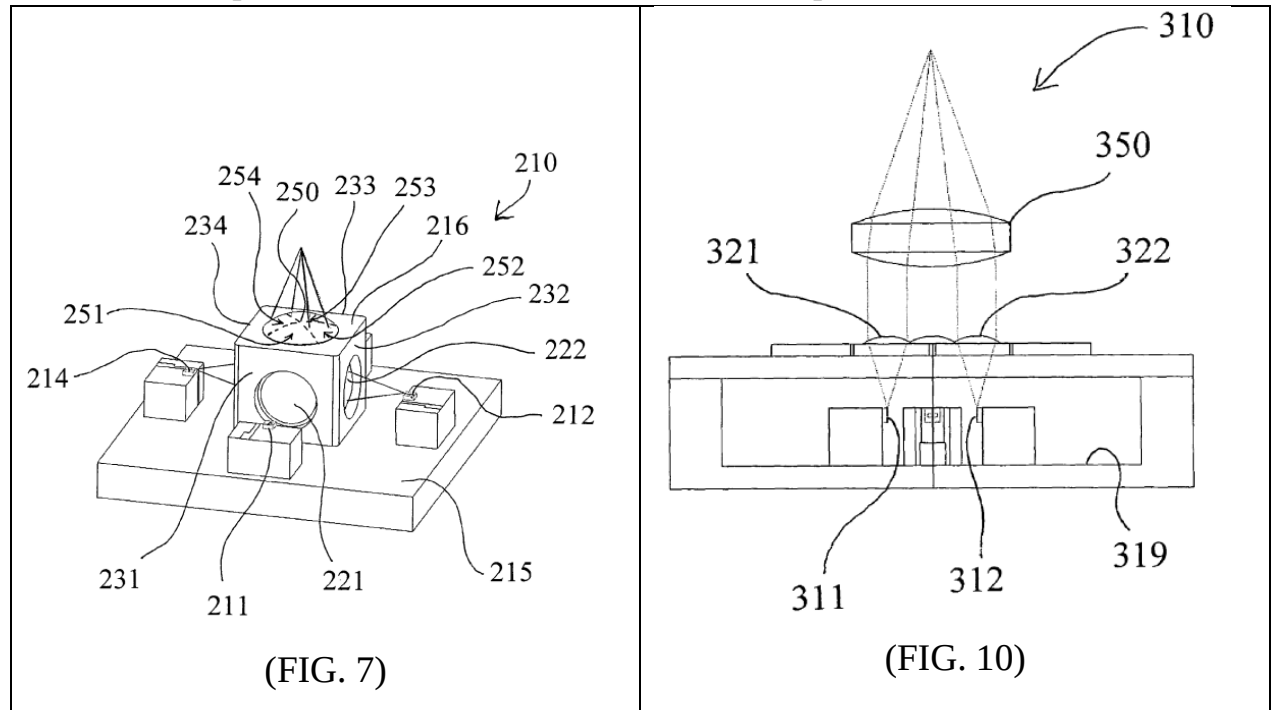
Lasers 11,12 are located at the focal points of the input lenses and the light is collimated, reflected off a prism 40 and focused by the focusing lens 30 onto a spot at which a single optical fiber (not shown) is **stopped by fiber stop or seat 60 formed in ferrule 80**.

Pins 71,72,73,74 are located to aid in affixing the combiner device

10 to the support (not shown) for the lasers. **The integrated ferrule 80 enables one to place an output fiber optic cable into the pre-aligned connector.**

'416 Patent, 3:11-18 (emphasis added). As discussed above, having the input of the optical fiber fixed in place was important for proper alignment.

107. The stop or seat 60 is illustrated with respect to the first embodiment (FIGS. 1-4), but the other three embodiments (FIGS. 5-11) do not show a stop or seat 60, or otherwise dictate how the optical fiber is fixed in place. For example, FIGS. 7 and 10 are reproduced below, and *do not show* a stop or seat 60:



What matters is that the light beams are focused to a single spot, not that the connector in which an optical fiber is inserted has any particular form. The connector described with respect to the first embodiment could be used here, but so could other connectors known in the art. The '416 Patent does not limit the connector that may be used in these embodiments.

108. There are other mechanisms besides a seat-and-ferrule by which a fiber may be fixed. Examples include clamping and v-grooves, among other possibilities. See, e.g., M J Wale, Self Aligned, Flip Chip Assembly of Photonic Devices with

Electrical and Optical Connections, Plessey Research and Technology [OpticisKR0007111-18]; Pentti Karioja et al., Comparison of Active and Passive Fiber Alignment Techniques for Multimode Laser Pigtailling in 2000 Electronic Components and Technology Conference [OpticisKR0007131-36]; R. Hauffe et al., Methods for Passive Fiber Chip Coupling of Integrated Optical Devices in IEEE TRANSACTIONS ON ADVANCED PACKAGING, VOL. 24, NO. 4, NOVEMBER 2001 [OpticisKR0007160-65].

109. In summary, based on how the term is used in the claims and specification, a POSITA would have understood that “stopped” means “fixed.” I note that “fixed” is used here in a spatial sense, i.e., such that movement in a spatial dimension is substantially limited.

**E. Term 5: “said lenses being spaced apart”**

| Plaintiff’s Proposed Construction | Opticis Korea’s Proposed Construction                                          |
|-----------------------------------|--------------------------------------------------------------------------------|
| said lenses are “not overlapping” | “said lenses not touching at any point”<br>(or in the alternative, indefinite) |

110. Claim 1 requires “a plurality of  $n$  collimating lenses, said lenses being spaced apart.” ’416 Patent, 5:28-29. I have been informed that the parties dispute whether lenses that are “spaced apart” require a space between them (i.e., are not touching). In my opinion, the plain language of the claims – “spaced apart” – should resolve the dispute. Lenses that are formed as a single, contiguous structure without spaces (as would be encompassed by Plaintiff’s proposed construction) are neither “spaced” nor “apart” as a POSITA would understand those terms.

111. The term “spaced apart” should be construed to mean what it plainly says. This is accomplished with Defendants’ construction, which requires that the lenses are not touching at any point. This construction gives meaning to both “spaced” and “apart” by requiring that there is some distance between the collimating lenses. That is, that they are “apart” due to the “space” between them. Because

“spaced apart” is not a technical term of art or redefined in the specification, I understand that the customary meaning of the term applies. Using this customary meaning, a POSITA would not say that lenses are spaced apart if they are touching at any point.

112. The problem with Inneos’s proposed construction of “not overlapping” is that it gives no meaning to either “spaced” or “apart.” Lenses that are not overlapping may have no space between them, and may not be apart from one another, yet they would apparently still be encompassed under Inneos’s construction. In effect, Inneos’s construction deprives the claim term “spaced apart” of meaning. Moreover, in my opinion, I do not agree that a POSITA would understand the term to have the meaning that Inneos proposes. Specifically, the term “overlapping” appears nowhere in the specification, and I am not aware of any evidence that this was the ordinary meaning of the term, or the way it is used by the ’416 Patent.

\*\*\*

113. If Opticis Korea’s construction is not adopted and the term “spaced apart” is considered to apply to lenses that are touching, then there is significant ambiguity about what the term means. The only mention in the specification of the term “spaced apart” is a single reference at column 3, line 9, noting that the combiner 10 shown in FIGS. 1-4 includes “four spaced apart input collimating lenses 21,22, 23,24.” ’416 Patent, 3:7-10.

**F. Term 6: “the output of said n laser output beams” (claim 1) / “the output of said laser output beams” (claim 7)**

| Plaintiff’s Proposed Construction                                                                                                                                                               | Opticis Korea’s Proposed Construction |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| Plain and ordinary meaning.<br>Alternatively, delete “output of” from each claim as a scrivener’s error resulting in the following claim language: “the said n laser output beams” // “the said | Indefinite                            |

laser output beams”

114. I have been informed that a district court may correct obvious minor typographical and clerical errors in patents *only if* the correction is not subject to reasonable debate based on consideration of the claim language and the specification. Here, I believe that the correction is subject to a reasonable alternate possibility.

115. I understand that Inneos has proposed correcting the claim language by deleting the words “output of” from the claims. I agree that this would be one reasonable way to correct the claim. However, I believe that this is not the only reasonable possibility.

116. For example, the patent discloses various optical components, such as a prism that can be used “for translating the optical beams from one axis to another.” ’416 Patent, 3:38-52 (“a redirectional prism”). The first and third embodiments use other optical components (a prism) to redirect output beams where the lasers are not on-axis with the focusing lens (*see* FIGs. 1 and 8); the second and third embodiments do not require these other components (*see* FIGs. 5 and 10). Given the alternatives presented in the ’416 Patent, it would be clear to a POSITA that a prism, or other optical component, could be interposed between the lasers and the collimating lenses. This would result in *an output of* the laser output beams (as the claim says) being received by the collimating lenses.

**VIII. RESERVATION TO RESPOND TO OPINIONS AND EXTEND  
REMARKS**

117. I reserve the right to amend or supplement my opinions if additional relevant information becomes available. Therefore, I specifically reserve the right to amend or supplement my opinions upon further discovery, production of additional information, and/or the submission of specific arguments or evidence by Defendant and/or its expert(s).

118. I have not yet prepared any additional demonstrations or demonstrative charts, presentations or other exhibits to summarize or explain my opinions, but may do so if asked to.

119. I declare under the penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Dated: Dec. 15, 2023

Respectfully submitted,



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Alan E. Willner

# Appendix A

## Biographical Sketch: Alan E. Willner

Alan Willner received a Ph.D. (1988) in Electrical Engineering from Columbia University and a B.A. (1982) in Physics and an Honorary Doctorate (*Honoris Causa*, 2012) from Yeshiva University. Prof. Willner was a Postdoctoral Member of Technical Staff at AT&T Bell Labs and a Member of Technical Staff at Bellcore. He is currently *Distinguished Professor of Electrical & Computer Engineering* and the *Andrew & Erna Viterbi Professorial Chair* in the Ming Hsieh Dept. of Electrical & Computer Eng. of the Viterbi School of Eng. at the Univ. of Southern California; he also has a joint appointment with Dept. of Physics & Astronomy of the Dornsife College. Prof. Willner has been a Visiting Professor at Columbia Univ., Univ. College London, and Weizmann Institute of Science. He has been a Member of the U.S. Army Science Board, a Member of the Defense Sciences Research Council (16-member body that provided reports to DARPA Director & Office Directors), and a member of many advisory boards. He was also Founder & CTO of Phaethon Communications, a company whose technology was acquired by Teraxion, that created the ClearSpectrum® dispersion compensator product line which is presently deployed in many commercial 40-Gbit/s systems worldwide.

Prof. Willner has received the following honors: Member of the U.S. National Academy of Engineering, International Fellow of the U.K. Royal Academy of Engineering, Presidential Faculty Fellows Award from the White House, Ellis Island Medal of Honor, IEEE Eric Sumner Technical Field Award, Packard Foundation Fellowship in Science & Engineering, John Guggenheim Foundation Fellowship, U.S. Dept. of Defense Vannevar Bush Faculty Fellowship, Fellow of National Academy of Inventors, Institution of Eng. & Tech. (IET) J.J. Thomson Medal, Thomas Egleston Medal for Distinguished Engineering Achievement (highest eng. award from Columbia Eng. Alumni Association), Optica (formerly Optical Society (OSA)) Paul Forman Engineering Excellence Award, IEEE Photonics Society Engineering Achievement Award, National Science Foundation National Young Investigator Award, Fulbright Foundation Senior Scholar Lecture & Research Fellowship, Honorary Professor of Huazhong Univ. of Science & Technology, Civilian Service Commendation Medal (US Dept. of the Army), IEEE Photonics Society Distinguished Lecturer Award, SPIE President's Award, IEEE Photonics Society Distinguished Service Award, USC Associates Award for University-Wide Creativity in Research (highest USC research award), USC Associates Award for University-Wide Excellence in Teaching (highest USC teaching award), OSA Robert Hopkins Leadership Award, USC Phi Kappa Phi Faculty Recognition Award (for significant scholarly work), Member of European Academy of Sciences and Arts, USC Senior Engineering Research Award, USC Best Engineering Teacher Award, 2001 Eddy Paper Award from Pennwell Publications for Best Contributed Technical Article (across all 30 magazines in Pennwell's Advanced Technology Division), IEEE Globecom Best Paper Award, and Edwin Howard Armstrong Foundation Memorial Award for highest-ranked EE Masters student at Columbia University. He is a Fellow of AAAS, APS, IEEE, IET, OSA, SPIE, and AAIA, and he was a Fellow of the Semiconductor Research Corporation. Prof. Willner was an invited foreign dignitary representing the sciences for the 2009 Nobel Prize Ceremonies in Stockholm.

Prof. Willner's activities include: Co-Chair of U.S. National Academies' Study on Optics & Photonics, President of the OSA, President of the IEEE Photonics Society (formerly LEOS), Co-Chair of OSA Science & Engineering Council, Vice-President for Technical Affairs of IEEE Photonics Society, Editor-in-Chief of OSA Optics Letters, Editor-in-Chief of the IEEE/OSA Journal of Lightwave Technology (JLT), Editor-in-Chief of the IEEE Journal of Selected Topics in Quantum Electronics, Associate Editor of the IEEE Journal of Selected Areas in Communications Series on Optical Networks, Photonics Division Chair of OSA, Chair of IEEE TAB Ethics and Member Conduct Committee, Chair of the National Photonics Initiative, General Co-Chair of the Conference on Lasers and Electro-Optics, Program Co-Chair of OSA Annual Meeting, General Chair of IEEE Photonics Society Annual Meeting, Program Chair of Telecommunications Engineering at SPIE's Photonics West, and Chair of the Unclassified Technical Program for IEEE MILCOM.

Prof. Willner has >1700 publications (*h-index*  $\geq 88$ , >40,000 citations, *Google Scholar*), including 1 book, ~10 edited books, ~46 US patents, ~54 keynotes/plenaries, ~25 book chapters, >430 refereed journal papers, and >300 invited papers/presentations. His research is in optical technologies (e.g., communications, signal processing, networks, and subsystems).

## FULL CV: ALAN ELI WILLNER

**ADDRESS:** EEB 538, Dept. of Electrical Engineering, Viterbi School of Engineering, USC, LA, CA 90089-2565, 213-740-4664, F: 213-740-8729, [willner@usc.edu](mailto:willner@usc.edu)

**EDUCATION:** **Columbia University - Ph.D.** - Electrical Engineering - Aug. 1988 (defended). Thesis Advisor - **Prof. Richard Osgood, Jr.**, Thesis Title: Laser-Controlled Photochemical Etching of Semiconductors for Electro-optical Devices  
**Columbia University - M.S.** - Electrical Engineering (1984)  
Overall Columbia grade index - **4.11** (A = 4.0)  
**Yeshiva University - B.A.**- Physics (1982). Grade index - **3.96** (A = 4.0)

**WORK EXPERIENCE:**

Fall '10 - present **Distinguished Prof. ('21), Ming Hsieh Dept. of Electrical & Computer Eng., Andrew & Erna Viterbi Professorial Chair ('22) Steven & Kathryn Sample Chair in Eng. ('10-'22), Viterbi School of Eng., Joint Appointment w/ Dept. of Physics & Astronomy, Dornsife College ('22) University of Southern California**  
• Optical Communication Systems and Networks

Mar. '15 - present Visiting Professor (Adj. Senior Res. Scientist), Elec. Eng. Dept., Columbia Univ.  
Sept. '17 - present Visiting Scholar, Yeshiva College and Stern College for Women, Yeshiva Univ.  
Fall '98 – Spring '10 Professor, Ming Hsieh Dept. of Electrical Eng., USC  
Sept. '09 – June '14 Member, **Defense Sciences Research Council**, Consultant to Booz Allen  
• Council performed studies that were presented to DARPA Director & Office Directors

Fall '07 - Summer '12 **Co-Director**, Communications Sciences Institute, EE Dept. Exec. Comm., USC  
Fall '07 -Summer '17 Visiting Professor, Dept. of Electronic & Electrical Eng., Univ. College London  
Nov. '99 - Nov. '02 **Founder & CTO**, Phaethon Communications (technology acquired by Teraxion)  
• Created the **ClearSpectrum®** dispersion compensator product line  
• ClearSpectrum® presently deployed in many commercial 40-Gbit/s systems

Aug. '94 - Sept. '98 Associate Professor, Dept. of EE - Systems, USC  
April '96 - June '04 Associate Director, Student Affairs, NSF-Sponsored Engineering Research Center in Integrated Media Systems, USC

Spring '98 **Visiting Fulbright Prof.**, Physics Dept., Weizmann Institute of Science, Israel  
Apr. '94 – Present Associate Director, Center for Photonic Technology (CPT), USC  
Jan. '92 - Present **Director, Optical Communications Laboratory**, USC  
Jan. '92 - July '94 Assistant Professor, Dept. of EE - Systems, USC  
Nov. '90 - Jan. '92 **Member of Technical Staff, Bell Comm. Research**, Photonics Research Dept.  
• Fiber Optic Wavelength-Division-Multiplexed Communication Systems

Oct. '88 - Oct. '90 **Postdoctoral Member of the Technical Staff**, Crawford Hill Lab  
**AT&T Bell Laboratories**, Photonics Networks and Components Research Department, Postdoctoral Supervisor: **Dr. Ivan Kaminow**

Sept. '84 - Aug. '88 Graduate Research Assistant, **Columbia University**, Microelectronics Science Lab & NSF Center for Telecommunications Research

Fall '87 **Instructor, Columbia Univ.**, “Fundamentals of Circuits and Systems”  
June '87 Visiting Scientist, Naval Research Laboratory - Modulation Spectroscopy  
Summers '83, '84 Summer Technical Staff, **David Sarnoff Research Center, RCA Labs**  
Fall '83 Teaching Assistant, Columbia Univ., Solid State Devices

**HONORS:**

**Member, U.S. National Academy of Engineering ('16)**

**U.K. Royal Academy of Engineering ('10)**

Of the 4 International Fellows elected from the US in '10, the other 3 were Drs. Howard Bruschi (former Westinghouse CTO), Robert Langer (MIT Institute Prof.) and Charles Vest (former MIT President and NAE President).

**Ellis Island Medal of Honor ('20)**

Awarded annually to a group of distinguished American citizens who exemplify a life dedicated to their community and the world at large.

**IEEE Eric E. Sumner Award ('14)**

One "Technical Field Award" in Communications from the entire IEEE.

**Vannevar Bush Faculty Fellowship (U.S. DoD) ('16)**

Formerly Defense Security Science & Eng. Faculty Fellowship (NSSEFF)

This is considered the DoD's most prestigious single-investigator research award.

**J. J. Thomson Medal for Achievement in Electronics, Institution of Engineering & Technology (IET) ('16)**

**Civilian Service Commendation Medal, US Department of the Army ('21)**

"For outstanding service as a member of the Army Science Board."

**Distinguished Professor of Electrical and Computer Engineering at USC ('21)**

**Andrew and Erna Viterbi Endowed Professorial Chair at USC ('22)**

Inaugural holder of endowed chair named for Dr. & Mrs. Viterbi.

**Steven and Kathryn Sample Endowed Chair in Engineering at USC ('10)**

Inaugural holder of endowed chair named after the former USC president.

**Fellow of the National Academy of Inventors ('15)**

**'09 Nobel Prize Ceremonies, "invited foreign dignitary representing sciences"**

**Thomas Egleston Medal for Distinguished Engineering Achievement ('17)**

Highest honor given to a Columbia engineering graduate for a lifetime of achievement in the engineering profession by the Columbia University Engineering Alumni Association. Notable previous winners include Edwin H. Armstrong, Harvey S. Mudd, and Hyman G. Rickover.

**Member, European Academy of Sciences and Arts ('21)**

**Albert Nelson Marquis Lifetime Achievement Award from Marquis Who's Who Publications Board ('17)**

**Viterbi School of Engineering Senior Research Award ('19)**

**Honorary Professor, Huazhong Univ. of Science & Technology (HUST) ('16)**

HUST is ranked as one of the top 10 universities in China.

**Honorary Doctorate, *Honoris Causa*, Yeshiva University, Commencement ('12)**

**John Simon Guggenheim Foundation Fellowship ('12)**

**HONORS: (CONTINUED)**

**Presidential Faculty Fellows Award ('94)**

30 awards are given annually by the **White House** to faculty in all areas of science and engineering. Sponsored by the NSF.

**David & Lucile Packard Foundation Fellowship in Science & Eng. ('93)**

20 awards given annually in science and eng.  
One of three engineering awards.

**NSF National Young Investigator Award ('92)**

Formerly the **Presidential** YI Award.

**Fulbright Foundation Senior Scholar Fellowship Award ('98)**

Pursue research and lecturing at the Weizmann Institute of Science.

**Optical Society of America (OSA) Paul Forman Eng. Excellence Award ('10)**

One award given in 2010 for technical achievements in optical engineering.

**IEEE Photonics Society Engineering Achievement Award ('11)**

One award given in 2011 for technical achievements in photonics.

**Optical Society of America (OSA) Leadership Award / New Focus Prize ('09)**

One given for significant contribution to society or impact on optics.

**SPIE President's Award ('13)**

**Fellow – American Physical Society (APS) ('21)**

**Fellow – American Assoc. for the Advancement of Science (AAAS) ('12)**

**Fellow – Institute of Electronic and Electrical Engineers (IEEE) ('04)**

**Fellow - Optical Society of America (OSA) ('96)**

**Fellow – Society for Photo-Instrumentation Engineers (SPIE) ('10)**

**Fellow - Institution of Engineering & Technology (IET) ('16)**

**Fellow – Asia-Pacific Artificial Intelligence Association (AAIA) ('22)**

**Best Contributed Technical Article, '01 Eddy Award, Pennwell Publications**

One award from all 30 magazines in Pennwell's Advanced Technology Division.

**Best Paper Award, IEEE Globecom Conference ('14)**

**Paper Selected as one of the '07 Highlights of *Nature Photonics* by its Editors**

Paper Selected: NP, vol. 1, no. 2, pp. 87-88, 2007.

**USC Associates Award, University-Wide Creativity in Research ('12)**

Two awards given from >2,000 professors at USC. Highest research award.

**USC Associates Award, University-Wide Excellence in Teaching ('03)**

Two awards given from >2,000 professors at USC. Highest teaching award.

**Phi Kappa Phi Faculty Recognition Award ('16)**

4 given at USC Academic Honors Convocation for significant scholarly work

**IEEE Photonics Society Distinguished Lecturer Award (99', 00')**

4 annual awards to present a distinguished lecture to local chapters worldwide.

**HONORS: (CONTINUED)**

**IEEE Photonics Society Distinguished Service Award '03**

1 annual award that recognizes exceptional individual contribution of service.

**HP Labs Research Innovation Award '08, '09, '10 (see also *Grants*)**

**Northrop USC Outstanding Junior Eng. Faculty Research Award '94**

Given to the **highest ranked** Asst. Prof. in the USC School of Engineering.

**Phi Kappa Phi Academic Honor Society, Faculty Inductee '04**

**Northrop/USC Best Electrical Eng. Research Impact Faculty Award '05**

**TRW USC School of Engineering Best Teacher Award '99**

Teaching award given to the highest ranked teacher in the School of Eng.

**NSF Alan T. Waterman Award Finalist ('95, '96, and '97)**

**Outstanding Teaching Award, Elec. Eng. Dept., USC Eng. School ('95, '97)**

**The Okawa Foundation Research Award '00**

**Senior Member – IEEE ('94)**

**Taiwan Government Travel Grant ('08)**

*“Academician of Academia Sinica or International Renowned Scholar”*

**Edwin Howard Armstrong Foundation Memorial Award**

Given to the **highest ranked** Columbia Univ. Elec. Eng. Masters Student

**IEEE LEOS Figure Contest Winner (L. Zhang, et al.) ('08)**

**Fellow - Semiconductor Research Corporation - Doctoral Research**

Representing Business Professionals from the State of California in Who's Who in America 2020 ('20)

Top 2% Most-cited Scientists Listed by Stanford University ('20)

Marquis Who's Who in America; ... in the World; ... in Science & Eng.

NATO/NSF Summer Fellowship (1985) - Italy

Columbia University Departmental Fellowship (9/83-5/86)

Dr. Samuel Belkin Scholar Award: Yeshiva University

Head Delegate to the Harvard Model United Nations from Yeshiva University

Magna Cum Laude: Yeshiva University

Student Council Member & Junior Class Vice-President: Yeshiva University

Valedictorian (high school); Editor-in-Chief, Yearbook (high school)

**JOURNAL EDITOR:**

**Editor-in-Chief, OSA Optics Letters ('08-'13)**

*#1 ranked Optics publication for 2007 in terms of ISI Impact Factor*

**Editor-in-Chief, IEEE/OSA Journal of Lightwave Technology ('01-'06)**

**Editor-in-Chief, IEEE J. of Selected Topics in Quantum Electronics ('99-'01)**

**Associate Editor, IEEE/OSA J. of Optical Communications & Networking ('09-'11)**

**Associate Editor, IEEE Journal of Selected Areas in Communications,**  
Series on Optical Communications and Networks (2002-2009)

**Associate Editor, IEEE/OSA Journal Lightwave Technology (1995-2000)**

**Guest Editor, MDPI Journal of Applied Sciences**

Special Issue on Novel Insights into Orbital Angular Momentum Beams: From Fundamentals and Devices to Applications ('19)

**Guest Co-Editor, Light: Science & Applications,**

Special Issue, Twisted Light with Orbital Angular Momentum ('17)

**Guest Editor, IEEE/OSA Journal of Lightwave Technology, Special Issue,**  
A Third of a Century of Lightwave Technology Jan. 1983-Apr. 2016 ('16)

**Guest Editor, IEEE Journal of Selected Topics in Quantum Electronics,**  
Special Issue, Optical Waveguides: Technologies and Applications ('16)

**Guest Editor, Nanophotonics (a de Gruyter journal),**

Special Issue, Advances in Optical Fiber Technology ('14)

**Guest Editor, IEEE Journal of Selected Topics in Quantum Electronics,**  
Special Issue, Optical Modulators - Technologies and Applications ('13)

**Guest Editor, IEEE Journal of Selected Areas in Communications,**  
Special Issue, Next-Generation Broadband Optical Access Network Techn. ('10)

**Guest Editor, Applied Physics-A (a Springer Verlag journal),**  
Special Issue on Photonic Interconnects (June 2009)

**Guest Editor, IEEE/OSA Journal of Lightwave Technology,**  
Special Issue on the 25<sup>th</sup> Anniversary of JLT (May '08)

**Guest Editor, OSA Journal of Optical Networking,**  
Special Issue on Optical Code-Division-Multiple-Access (2007)

**Guest Editor, IEEE Journal of Selected Topics in Quantum Electronics,**  
Special Millennium Issue (Dec. 2000)

**Guest Editor, IEEE Journal of Quantum Electronics**

Focus Issue on Ultra-High-Bandwidth Optical Transmission Systems (Nov. 1998)

**Guest Editor, IEEE/OSA Journal of Lightwave Technology & IEEE Journal of Selected Areas in Communications,**  
Joint Special Issue, Multiple-Wavelength Technologies and Networks (June '96)

**PROFESSIONAL ACTIVITIES:**

**General Chair,**  
OptoElectronics and Communications Conference (OECC), Shanghai ('23)

Member, Technical Program Committee, Conference on High Contrast  
Metastructures XII, SPIE Photonics West ('23)

**Chair,** Committee for the Optica Foundation Challenge Contest ('22)

Member, IEEE Edison Medal Committee ('22)

**Co-Chair,** Workshop on High-Capacity Wireless Communications  
IEEE Global Communications Conference (GLOBECOM) ('22)

**Chair,** External Review Panel on Electronics Science and Technology Focus Area,  
Naval Research Laboratory ('22)

**Co-Chair,** Technical Program Committee,  
Workshop on Orbital Angular Momentum Transmission, IEEE International  
Conference on Communications (ICC) ('22)

Member, Tingye Li Memorial Scholarship Nomination Review Committee,  
Photonics Society of Chinese Heritage (PSC) ('20-'23)

Workshop Participant, Crystal Ball Workshop,  
The U.S. OSD R&E, USSF, and U.S. AFRL ('22)

Member, Organizing Committee, ComSoc Student Conference,  
IEEE WCNC 2022 ('22)

Co-Lead of Photonics Group,  
Future Directions Workshop on Wireless Communications: XG and Beyond,  
Basic Research Office of the Office of the Under-Secretary of Defense ('22)

Member, International Advisory, Photonics Research Institute,  
Hong Kong Polytechnic University ('22-'24)

**General Co-Chair,**  
Asia Communications and Photonics Conference (ACP), Shanghai ('21)

**Optica (formerly The Optical Society (OSA)) (Membership ~20,000)**

**Past-President (2017)**

**President (2016)**

**President-Elect (2015)**

**Elected Vice President (2014)**

**PROFESSIONAL ACTIVITIES: (CONTINUED)**

U.S. National Academy of Engineering, Member Search Committee, Section 7,

- **Chair** (2018)
- **Vice-Chair** (2017)
- **Past Chair** (2019)
- Member ('20-'22)

Member, Technical Program Committee,  
Workshop on Orbital Angular Momentum Transmission, IEEE International  
Conference on Communications (ICC) ('21)

Member, Technical Program Committee,  
Adaptive Optics: Methods, Analysis and Applications, OSA Imaging and Applied  
Optics Congress ('20)

**Co-Chair**, Workshop on High-Capacity Wireless Communications  
IEEE Global Communications Conference (GLOBECOM) ('20)

Member, Review Panel on Engineering Sciences at the Army Research Office,  
Laboratory Assessments Board, US National Academies ('20)

Member, Advisory Board, Advances in Optics and Photonics (AOP) ('20-'23)

Member, Technical Program Committee,  
Workshop on Orbital Angular Momentum, IEEE International Communications  
Conference (ICC) ('20)

Member, Technical Program Committee,  
OSA Topical Meeting on Adaptive Optics, OSA Imaging and Applied Optics  
Congress, Vancouver, Canada ('20)

Member, Technical Program Committee,  
SPIE Photonics West, Advanced Optical Techniques for Quantum Information,  
Sensing, and Metrology conference ('20)

**Co-Chair**, Workshop on High-Capacity Point-to-Point Wireless  
Communications Program,  
IEEE Global Communications Conference (GLOBECOM) ('19)

**Co-Chair**, Workshop on Electromagnetic Wave Transmission with Orbital  
Angular Momentum,  
IEEE International Conference on Communications (ICC) ('19)

Member, Planning Committee,  
DMMI Workshop on Domestic Manufacturing Capabilities for Critical DoD  
Applications: Emerging Needs in Quantum-enabled Systems, National  
Academies ('19)

**PROFESSIONAL ACTIVITIES: (CONTINUED)**

Member, National Academies Review Panel  
*“An Assessment of the National Institute of Standards and Technology  
Physical Measurements Laboratory”* ('19)

Member, Distinguished Service Award Committee,  
IEEE Photonics Society ('19)

**Honorary Chairs,**  
Asia Communications and Photonics Conference (ACP), Chengdu ('19)

**Co-Chair,** Charles Kao's Symposium on Optical Fiber Communications,  
Asia Communications and Photonics Conference (ACP), Chengdu ('19)

Mentor, Undergraduate Engineering/Robotics Club  
Yeshiva Univ. (Yeshiva College and Stern College) ('18-'19)

Member, Department of Defense Bush Fellows Research Study Team ('18-'20)

Member, OSA Nominating Committee ('17-'19)

Member, Editorial Board,  
Progress in Electromagnetics Research (PIER) ('17-'23)

Member, Independent Technical Advisory Board,  
DoD Applied Research for the Advancement of S&T Priorities (ARAP) Defense  
Optical Channel Program (DOC-P) ('17-'19)

Member, International Advisory Committee (IAC),  
The Optics & Photonics Taiwan ('17)

**Chair,** Committee,  
IEEE Eric Sumner Technical Field Award ('16-'18)

Member, SRI Technology Council ('16-'19)

Member, Technical Program Committee, Subcommittee Photonics in Switching  
System and Related Technologies, Photonics in Switching ('16)

**General Co-Chair,**  
IEEE/OSA/SPIE Asia Communications & Photonics Conference, Wuhan ('16)

**Co-Organizer,** Workshop on Twisting Light with Orbital Angular Momentum  
(OAM): Advances and Opportunities,  
IEEE/OSA/SPIE Asia Communications & Photonics Conf (ACP), Wuhan ('16)

**PROFESSIONAL ACTIVITIES: (CONTINUED)**

National Spectrum Consortium (NSC) Representative, Subject Matter Expert, Communications Assessment Working Group ('16)

Member, Technical Program Committee, SPIE Photonics West, Conference on Advances in Photonics of Quantum Computing, Memory, and Communication ('16-'19)

Member, Conference Program Committee, SPIE Photonics West, High-Contrast Metastructures IV Conference ('15-'20)

**Chair**, Steering Committee, National Photonics Initiative (NPI) ('15-'17)

Member, Organizing Committee, Conference FIAT LUX on the International Year of Light (IYL), Rome ('15)

Member, International Advisory Board, School of Engineering Sciences (SES) of Huazhong University of Science and Technology (HUST), Wuhan, China ('14-'17)

Member, Technical Program Committee, European Conference on Optical Communications (ECOC) ('13, '14, '15)

Member, Technical Program Committee, Systems Subcommittee, Photonics in Switching ('13, '14)

Member, **U.S. Army Science Board** ('14-'20)

Member, **Foundation Board of Directors**, OSA ('14)

Member, **Advisory Board**, National Science Review ('14)

**Consultant Member**, U.S. Army Science Board ('13-'14)

**Co-Organizer**, Section on Optics and Photonics: An International Perspective, American Association for the Advancement of Science (AAAS) Annual meeting, Chicago ('14)

**Chair-Elect and Member**, Steering Committee National Photonics Initiative (NPI) ('13-'14)

**Chair**, Unclassified Technical Program, IEEE MILCOM (San Diego, CA) (2013)

**Co-Chair**, U.S. National Academies Committee for NRC Study, *“Optics and Photonics: Essential Technologies for Our Nation”* (2011-2012)

**PROFESSIONAL ACTIVITIES: (CONTINUED)**

**Chair**, Steering Committee,  
APS/IEEE/OSA Conf. on Lasers & Electro-Optics (CLEO) ('08-'10&'10-'12)  
Member, **Defense Science Research Council**,  
Council submits reports to DARPA Director and Office Directors ('09-'14)

**Elected Member-at-Large**, Section on Engineering,  
American Association for the Advancement of Science (AAAS) ('12-'16)

Member, 2015 IEEE Eric E. Sumner Award Committee ('15-'16)

Member, Steering Committee,  
Optoelectronics Communications Conference (OECC) ('14)

Member, Technical Program Committee,  
22nd Wireless and Optical Communication Conference ('13)

Member, Technical Program Committee, Systems Subcommittee,  
Photonics in Switching ('13, '14)

Member, External Advisory Committee,  
Department of Electrical & Computer Eng., Johns Hopkins Univ. ('09-'21)

Member, International Advisory Committee,  
International Conference on Fiber Optics and Photonics, Madras ('12)

Member, Technical Program Committee,  
European Conference on Optical Communications (ECOC) ('12)

Member, Technical Program Committee, Globecom GC12,  
Optical Networks & Systems Symposium (ONS) (2012)

Member, Technical Program Committee, Systems Subcommittee,  
Photonics in Switching 2012

National Academy of Engineering Representative,  
US Advisory Committee, International Commission on Optics ('10-'12,'13-'15)

Co-Chair, Technical Program Committee, SPIE Photonics West,  
Conference on High Contrast Metastructures (OE131), San Francisco ('12)

**General Co-Chair**, OSA Topical Meeting on  
Signal Processing in Photonic Communications (SPPCOM), Toronto (2011)

**PROFESSIONAL ACTIVITIES: (CONTINUED)**

**IEEE Photonics Society (Membership~7,000)**  
*(Formerly the IEEE Lasers & Electro-Optics Society (LEOS))*

**President (2006-2007)**

**Past-President (2008-2009)**

**President-Elect (2004-2005)**

Member, Strategic Planning Committee,  
IEEE Technical Activities Board (2011-2013)

Member, Board of Editors, OSA ('08-'13)

**Chair**, Awards Committees, IEEE Photonic Society (2010)

Member, Technical Program Committee, IEEE Photonics Society,  
Summer Topical Meeting on Terabit Optical Ethernet, Montreal (2011)

Member, International Advisory Committee,  
IQEC / CLEO Pacific Rim Conference, Sydney (2011)

Member, Technical Program Committee,  
7th Workshop on Fibre Optics & Passive Components, July, Montreal (2011)

Member, International Advisory Committee,  
1<sup>st</sup> International Postgraduate Student Conference (PGSC), Singapore (2011)

Member, Conference Program Committee, SPIE Photonics West,  
Free-Space Laser Communication Technologies XXIII (2011)

**Program Co-Chair**, OSA Topical Meeting on  
Signal Processing in Photonic Communications (SPPCOM), Germany (2010)

**Symposium Co-Chair**, European Conf. on Optical Communications (Italy) ('10)  
C. Kao's Nobel Prize & Early Development of Optical Fibres and Optical Comm.

Member, Technical Program Committee,  
European Conference on Optical Communications (ECOC) ('00, '11, '12)

**Chair** ('08) and Member ('10), Int'l Advisory Committee,  
IEEE Photonics Global Singapore

**General Co-Chair**, IEEE Photonics in Switching Conference, Pisa, Italy (2009)

Member, Board of Visitors,  
Army Research Office (ARO) Electronics Division ('10)

**PROFESSIONAL ACTIVITIES: (CONTINUED)**

Member, Technical Program Committee,  
OSA Topical Meeting on Photonics in Switching, Monterey, CA ('10)

Member, Technical Program Committee,  
Optical Networks & Systems Symposium, IEEE Globecom, Miami ('10)

Member, International Advisory Committee (IAC),  
BGPP'10 (Bragg Gratings, Photosensitivity, & Poling), Germany ('10)

Member, International Advisory Committee,  
3<sup>rd</sup>Int'l Photonics & OptoElectronics Meetings (POEM), Wuhan ('10)

**Co-Chair**, Technical Subcommittee,  
Optical Transmission Systems, Switching and Subsystems,  
IEEE/OSA/SPIE Asia Communications & Photonics Conf (ACP), Shanghai ('09)  
Member, Conference Committee, IEEE/LEOS Summer Topical Meeting,  
The Future Global Network, CA (2009)

Member, Conference Committee, IEEE/LEOS Summer Topical Meeting,  
Optical Code Division Multiple Access (OCDMA), CA (2009)

Member, Publication Advisory Board,  
OSA's Advances in Optics & Photonics (AOP) ('08-'09)

Member, Editorial Advisory Board, Lightwave Magazine, Pennwell Publishers

Member, Int'l Advisory Committee,  
8th Int'l Conf. on Optical Communications & Networks (ICOON), Beijing ('09)

Member, IEEE Photonics Soc. Distinguished Service Award Committee ('08,'09)

Member, Technical Program Committee, Globecom,  
Optical Networks & Systems Symposium (ONSS), Hawaii (2009)

Member, Conference Program Committee, SPIE Photonics West,  
Advanced Optical Concepts in Quantum Computing, Memory, & Comm. (2009)

Member, Conference Program Committee, SPIE Photonics West,  
Free-Space Laser Communications, CA (2009)

Member, Tech. Prog. Comm., Symp. on Optical Fiber Devices & Applications,  
Int'l Conf. on Materials for Advanced Technologies (ICMAT), Singapore (2009)

Member, OSA Review Committee of the J. of the Optical Society of Korea ('09)

**PROFESSIONAL ACTIVITIES: (CONTINUED)**

**Program Co-Chair**, OSA Topical Meeting on  
Coherent Optical Technologies and Applications (COTA) (2008)

Member, Technical Program Committee,  
CS/IEICE Int'l Conference on Photonics in Switching, Sapporo, Japan (2008)

Member, Tech. Prog. Comm., ONS (Optical Networks & Systems Symposium),  
IEEE Int'l Conference on Communications (ICC) (2008, 2009)

Member, Optical Network & Broadband Access Subcommittee,  
Opto-Electronics and Communications Conference, Sydney (2008)

**Chair**, Ethics and Conflict Resolution Committee,  
IEEE Technical Activities Board (TAB) (2007)

Member, Strategic Planning Committee,  
IEEE Technical Activities Board (2008-2010)

Member, New Initiatives Committee, IEEE-Wide Committee (2008)

**General Co-Chair**, OSA Topical Meeting on Slow & Fast Light (2007)

Member, Ethics and Member Conduct Committee Hearing Panel,  
IEEE Institute-Wide (2006-2008)

Member, Frederic Ives Medal/Jarus Quinn Endowment Award Committee,  
highest award of the Optical Society of America (OSA) ('06,'07)

Member, International Program Committee (IPC),  
International Association of Science & Technology for Development (IASTED)  
Int'l Conf. on Wireless and Optical Communications (WOC), Quebec 2008  
Int'l Conf. on Communication, Internet & Info. Tech. (CIIT), Banff (2007)  
Int'l Conf. on Power and Energy Systems, Thailand (2007)  
Int'l Conf. on Wireless and Optical Communications, Montreal (2007)

**Co-Organizer**, Workshop on Slow Light,  
Conference on Optical Fiber Communications 2007

**Chair**, Steering Committee, AOE Expo and Conference, Shanghai (2007)

**Program Co-Chair**, OSA Topical Meeting on Slow & Fast Light (2006)

**Chair**, Communications Subcommittee, OSA Topical Meeting  
Coherent Optical Technologies and Applications (COTA) (2006)

**PROFESSIONAL ACTIVITIES: (CONTINUED)**

**Co-Chair**, Science and Engineering Council (2001-2003),  
Optical Society of America (OSA) (Total Membership~15,000)

**Workshop Co-Chair**, The Future of Optical Telecommunications,  
European Conf. on Optical Communications (Cannes) ('06)

**Chair**, External Int'l Review Panel, Research Program in Network Technol.,  
National ICT Australia (NICTA), University of Melbourne ('06-'07)

Member, Technical Program Committee, IEEE LEOS Summer Topical Meetings  
Quantum Communications in Telecom Networks (2006)

Member, Board of Directors, NSERC Canada Research Center,  
Agile All-Photonics Networks (AAPN) ('05-'10)

**Chair**, Membership Committee,  
IEEE Lasers & Electro-Optics Society (LEOS) ('04-'06)  
Member, Technical Program Committee, Photonics in Switching,  
OSA Topical Meeting, Greece (2006)

Member, International Program Committee, IASTED,  
Int'l Conf. on Comm., Internet and Information Tech., St. Thomas, USVI ('06)

**Chair**, Distinguished Service Award Committee,  
IEEE Lasers & Electro-Optics Society (LEOS) ('04,'05,'06)

**Chair**, Planning Committee, Science & Engineering Council,  
Optical Society of America (OSA) ('04)

Member, Technical Program Committee, Optical Signal Processing,  
IEEE LEOS Summer Topical Meetings (2005)

Member, Technical Program Committee,  
Photonic Technologies for Communications, IEEE Globecom, St. Louis (2005)

Member, Technical Prog. Committee, Optical Systems & Networks Symposium  
IEEE International Communications Conference (ICC) 2006, Turkey

Member, International Steering Committee, Asia-Pacific Optical and Wireless  
Communications Conference (APOC), Beijing, Shanghai, Korea ('04,'05,'06)

Member, International Advisory Committee,  
Symp. on Technology Fusion of Optoelectronics and Communications (STFOC),  
International Conference on Photonics ('05)

**PROFESSIONAL ACTIVITIES: (CONTINUED)**

**Steering Committee**, Conf. on Optical Fiber Communications (**OFC**) (99-04)  
Budget Subcommittee ('02-'03)  
Long-Range Planning Committee ('03-'04)

**Vice-President**, Technical Affairs (1996-1999),  
IEEE Lasers & Electro-Optics Society (LEOS) (Membership~7,500)  
Responsible for all Technical Affairs, including Technical  
Council, Standards Committees, & Gov't Liaison Committees

**Conference on Lasers and Electro-Optics (CLEO)**  
(>1000 invited & contributed papers, >6000 attendees)

**General Co-Chair (2003)**

**Program Co-Chair (2001)**

Member, Long Range Planning Subcomm., Steering Committee ('03)  
Co-Chair, Lasers and Electro-Optics Applications Program (2002)

**Committee Chair**, Lightwave Communications (2000)

Member, Program Committee ('97, '98, '99)

Member, **Board of Directors, OSA (2001-2003)**

**Workshop Co-Chair**, Ultra-High Capacity Optical Communications and  
Networking: Challenges in Broadband Optical Access, Materials Processing, and  
Manufacturing, **National Science Foundation (2002)**

**Chair**, Distinguished Traveling Lecturer Awards Committee, IEEE LEOS ('02)

Member, Curriculum Committee, NSF-Funded Advanced Technology Education  
(ATE) Planning Grant for the California Optical and Photonics Technology  
Education Center (Cal-OPTEC) at San Jose City College ('03-'04)

Member, Technical Program Committee, Optical Interconnects,  
**IEEE LEOS Summer Topical Meeting '04**

Member, Technical Program Committee, IASTED,  
Int'l Conf. on Optical Communication Systems & Networks, Banff, Canada (04)

Member, **Technical Program Committee**, Photonics In Switching, Paris ('03)

Member, International Advisory Committee, Asia-Pacific Optical and Wireless  
Communications Conference (APOC), Wuhan, China ('03)

Member, **Advisory Board**, Photonics Technology Access Program (PTAP),  
Optoelectronics Industry Development Association

Member, **Public Policy Committee**, OSA ('03)

**PROFESSIONAL ACTIVITIES: (CONTINUED)**

Member, **Publications Council**, Liason to Science & Eng. Council, OSA ('03)

Member, **Board of Editors**, OSA ('01-'6)

Member, **Finance Committee**, OSA ('02-'04)

Member, **Nominating Committee for President and Directors**, OSA ('00)

**Elected Member of the Board of Governors, IEEE LEOS ('98-'01)**

Member, Technical Program Committee, IASTED,

Int'l Conf. on Comm., Internet & Information Technology, Scottsdale, AZ ('03)

Member, **Technical Program Committees**,

IEEE LEOS Summer Topical Meetings '02:

(1) Fast Optical Signal Processing in Optical Transmission Committee

(2) Dynamic Enablers of Next-Gen Optical Comm. Systems Committee

**Steering Committee Member**,

IEEE Workshop on Fiber & Optical Passive Components, Sept., Italy (02,04,05)

Member, Technical Program Committee, IASTED,

Wireless & Optical Comm. Conference, Banff, Canada (2002)

**IEEE Lasers and Electro-Optics Society (LEOS) Annual Meeting**

(570 invited & contributed papers, ~ 800 attendees)

**General Chair (1999)**

**Program Chair (1997)**

**Program Co-Chair, OSA Annual Meeting 2001**

OSA Topical Meeting on Optical Amplifiers and Their Applications

**General Co-Chair (1999)**

**Technical Co-Chair (1998)**

**Chair, Systems Applications (1997)**

**Program Committee Member (1996)**

**Chair, Photonics Division, Technical Council,**

**Optical Society of America ('98-'00)**

**Workshop Co-Chair, The Future Revolution in Optical Communications & Networks, National Science Foundation (2000)**

Member, Technical Program Committee, IEEE Microwave Photonics Conf. ('01)

**PROFESSIONAL ACTIVITIES: (CONTINUED)**

Member, Optoelectronics Task Force, Semiconductor Research Corp. ('01)  
Member, Technical Program Committee, CLEO Pacific Rim ('01)

Member, Technical Program Committee,  
Optoelectronics Communications Conference (OECC), Sydney ('01)

Member, Technical Program Committee, Optical Networking Subcommittee,  
Asia-Pacific Optical and Wireless Communications Conference (APOC)

- (1) Beijing ('01)
- (2) Shanghai ('02)

Member, Technical Program Committee, SPIE, Photonics West,  
WDM and Photonic Switching Devices for Network Applications, San Jose ('01)

Member, Technical Program Committee,  
International Conference on Fiber Optics and Photonics, Calcutta ('01)

**Chair**, Standing Tech. Committee,  
Optical Networks, **IEEE LEOS (1996-1999)**

**Co-Chair, IEEE LEOS Summer Topical Meeting '98,**  
**Broadband Optical Networks: An Emerging Reality**

Member, **Scientific Advisory Board**, U.S./Japan Joint Optoelectronics  
Project, **Optoelectronics Industrial Development Association**

**Workshop Co-Organizer, Conference on Optical Fiber Communications**  
(1) Passive Optical Devices ('98)  
(2) Systems Software Modeling ('98,'99,'00,'01)

**Member**, US Advisory Committee,  
**International Commission on Optics ('97-'02)**

**Member**, IEEE Tech. Activities Board Subcommittee on  
New Technology Directions '96, '97

**Conference Program Committee, SPIE, Optical Comm., Taiwan ('98)**

**General Co-Chair, IEEE LEOS Summer Topical Meeting '97,**  
**Technologies for the Global Information Infrastructure**

**Invited Workshop Participant**, Frontiers in Engineering,  
**National Academy of Engineering** (nominations of engineers <40 years old)

**Chair**, Optical Communications Technical Committee, **IEEE LEOS ('94-'96)**

**PROFESSIONAL ACTIVITIES: (CONTINUED)**

**Vice-Chair**, Optical Communications Group, Technical Council,  
Optical Society of America (OSA) ('93-'97)

**Conference General Co-Chair**, IEEE LEOS Summer Topical  
Meeting '95, Technologies for the Global Information Infrastructure

**Program Committee**, System Technologies,  
Conference on Optical Fiber Communications (OFC) ('96-'98)

**Program Committee**, IEEE LEOS Summer Topical Meeting ('96),  
Broadband Optical Networks and Their Enabling Technologies

**Chair, Optical Communications Committee**,  
LEOS Annual Meeting ('94-'96)

**Standing Technical Committee**,  
**IEEE LEOS, Optical Networks** ('93-'96)  
**Program Chair**, Telecommunications Engineering, Society of Photo-  
Instrumentation Engineers (**SPIE**), Photonics West ('95)

**Chair**, Conf. on Emerging Technologies for All-Optical Networks,  
SPIE ('95-'96)

**Chair**, Information & Comm., NSF Forum on Optical Science & Eng. ('95)

**Chair**, Symposium, System Modeling, Conf. on Integrated Photonics Res. '96

**Technical Program Committee**, Committee on Numerical Modeling, IPR '96

**Awards Committee Member**,  
**IEEE LEOS Fellows Selection Committee** ('00)

**Awards Committee Member**,  
IEEE LEOS Distinguished Traveling Lecturer Award ('01, '03, '04)

**Awards Committee Member**,  
IEEE LEOS Wm. Streifer Scientific Achievement ('96, '03, '04, '05)

**Awards Committee Member**, IEEE LEOS Quantum Electronics Award ('97)

**Technical Committee**, IEEE Interconnects Workshop ('96)

**Chair**, Panel on Optical Information and Communications, Workshop on Optical  
Science and Engineering, National Science Foundation ('94)

**PROFESSIONAL ACTIVITIES: (CONTINUED)**

**Technical Program Committee**, Symposium Organizer,  
Optical Society of America Annual Meeting:

'98 (WDM Systems)

'96 (Optical Networks)

'95 (Wavelength Conversion Techn.)

'92 (EDFA Appl.: Distribution)

**Conf. Program Committee, SPIE**,  
Components for WDM ('95,'99,'00,'01,'02)

**Program Committee**, IEEE/ACM/SPIE Workshop on Optical Networks, ('00)

**Standing Technical Committee, IEEE LEOS, Optical Comm.** ('92-'94)

**Program Committee**, IEEE LEOS Ann. Meeting '92,'93; Lightwave Comm.

**Review Panel Member, NSF**, Optical Communications  
('92,'93,'94,'95,'97,'98,'03)

**TEACHING:**

**STUDENT EVALUATIONS**

**I. Univ. of Southern California (5.0 is highest possible score)**

Average student evaluations for all USC courses since 1992: 4.94/5.0

***Undergraduate Course: Introduction to Communications (EE 467)***

1. Spring '22: **5.0/5.0**, 11 students, 11 had evaluated
2. Spring '21: **4.70/5.0**, 11 students, 10 had evaluated
3. Spring '20: **4.95/5.0**, 29 students, 21 had evaluated
4. Spring '19: **4.83/5.0**, 21 students, 18 had evaluated
5. Spring '18: **5.0/5.0**, 27 students, 16 had evaluated
6. Spring '17: **4.91/5.0**, 15 students, 11 had evaluated
7. Spring '16: **4.96/5.0**, 27 students, 27 had evaluated
8. Spring '15: **4.96/5.0**, 27 students, 24 had evaluated
9. Spring '14: **4.84/5.0**, 25 students, 19 had evaluated
10. Spring '13: **5.0/5.0**, 21 students, all had evaluated
11. Spring '12: **4.94/5.0**, 20 students, 18 had evaluated
12. Spring '11: **5.0/5.0**, 22 students, 18 had evaluated
13. Spring '10: **5.0/5.0**, 19 students, 16 had evaluated
14. Spring '09: **5.0/5.0**, 10 students, all had evaluated
15. Fall '07: **5.0/5.0**, 11 students, all had evaluated
16. Fall '06: **5.0/5.0**, 10 students, 9 had evaluated
17. Fall '04: **5.0/5.0**, 11 students, all had evaluated
18. Fall '03: **5.0/5.0**, 7 students, all had evaluated
19. Fall '02: **5.0/5.0**, 11 students, all had evaluated
20. Fall '01: **5.0/5.0**, 21 students, all had evaluated
21. Fall '00: **5.0/5.0**, 20 students, all had evaluated
22. Fall '99: **5.0/5.0**, 22 students, 21 had evaluated
23. Fall '98: **5.0/5.0**, 18 students, all had evaluated
24. Fall '97: **5.0/5.0**, 22 students, all had evaluated
25. Fall '96: **4.92/5.0**, 14 students, all had evaluated
26. Fall '95: **5.0/5.0**, 8 students, all had evaluated
27. Fall '94: **5.0/5.0**, 9 students, all had evaluated
28. Fall '93: **5.0/5.0**, 8 students, all had evaluated
29. Fall '92: **5.0/5.0**, 13 students, all had evaluated

***Graduate Course: Optical Fiber Communications Systems (EE 558)***

1. Fall '19: **4.95/5.0**, 20 students, 19 had evaluated
2. Fall '18: **4.91/5.0**, 25 students, 23 had evaluated
3. Fall '17: **4.95/5.0**, 24 students, 22 had evaluated
4. Fall '16: **4.94/5.0**, 22 students, 17 had evaluated

5. Fall '15: **5.0/5.0**, 24 students, 19 had evaluated
6. Fall '14: **4.95/5.0**, 29 students, 22 had evaluated
7. Fall '13: **5.0/5.0**, 26 students, 24 had evaluated
8. Fall '11: **4.88/5.0**, 29 students, 24 had evaluated
9. Fall '10: **4.96/5.0**, 35 students, 28 had evaluated
10. Fall '09: **4.97/5.0**, 31 students, 30 had evaluated
11. Fall '08: **4.94/5.0**, 33 students, all had evaluated
12. Spring '08: **4.88/5.0**, 28 students, 25 had evaluated
13. Spring '07: **4.92/5.0**, 29 students, 24 had evaluated
14. Spring '06: **5.0/5.0**, 20 students, 17 had evaluated
15. Spring '05: **4.97/5.0**, 31 students, 29 had evaluated
16. Spring '04: **4.91/5.0**, 24 students, 23 had evaluated
17. Spring '03: **4.88/5.0**, 26 students, 25 had evaluated
18. Spring '02: **4.73/5.0**, 30 students, all had evaluated
19. Spring '01: **5.0/5.0**, 25 students, 24 had evaluated
20. Spring '00: **4.95/5.0**, 22 students, all had evaluated
21. Spring '99: **5.0/5.0**, 17 students, all had evaluated
22. Spring '97: **4.79/5.0**, 23 students, all had evaluated
23. Spring '96: **4.93/5.0**, 29 students, all had evaluated
24. Spring '95: **4.97/5.0**, 31 students, all had evaluated
25. Spring '94: **4.93/5.0**, 28 students, 27 had evaluated
26. Spring '93: **4.93/5.0**, 40 students, all had evaluated
27. Spring '92: **4.72/5.0**, 19 students, all had evaluated

## **II. Columbia Univ. (while a graduate student) (10.0 is highest possible score)**

### ***Undergraduate Course: Fundamentals of Circuits and Systems***

1. Fall '87: **8.3/10.0**, 110 students, 93 had evaluated

**Ph.D. THESES ADVISED AND GRANTED:**

1. Syang-Myau Hwang, 10/95, "System Performance and Channel Equalization of Optically-Amplified WDM Long-Distance Links and Ring Networks"
2. Andrew David Norte, 1/96, "Experimental Demonstrations of Wavelength Routing Functions for an All-Optical Wavelength-Division-Multiplexed Fiber Optic Communication Network Switching Node"
3. William Shieh, 3/96, "Experimental and Theoretical Study of All-Optical Wavelength Shifting Techniques by using Semiconductor Optical Amplifiers"
4. Eugene Park, 3/96, "Applications of All-Optical Wavelength Shifting using Semiconductor Optical Amplifiers for Switching and Routing Functions in a Dynamically Reconfigurable Wavelength-Division-Multiplexed Fiber-Optical Communication Network"
5. James E. Leight, 8/96, "System and Network Implementations of 2-D Multiple-Plane Wavelength-Division-Multiplexed Optical Interconnects"
6. J.-C. Wu, 8/96, "Protocols and Design Tradeoffs for Packet-Switched WDM Networks with Large Tuning Latencies"
7. M. Imran Hayee, 12/98, "Modeling of Dispersion and Nonlinearities in High-Performance Transmission"
8. Jin-Xing Cai, 6/99, "Experimental Demonstrations of Techniques to Improve System Performance in Non-Static Optical Wavelength Division Multiplexing Systems and Networks"
9. Kai-Ming Feng, 6/99, "System Performance Improvement in Optical Wavelength Division Multiplexing Systems and Networks using Optical Gratings"
10. Jong-Jin Yoo, 12/99, "System Performance and Network Structure of Two-Dimensional Multiple-Plane WDM Optical Interconnects"
11. Steve A. Havstad, 9/00, "Generation, Filtering, and Applications of Subcarriers in Optical Communication Systems"
12. Sanggeon Lee, 9/00, "Characterization and Compensation of Polarization Mode Dispersion and Chromatic Dispersion Slope Mismatch for High Bit-Rate Data Transmission"
13. Reza Khosravani, 10/00, "Reduction of Signal Degrading Effects in Wavelength Division Multiplexed Systems and Networks"
14. Mustafa C. Cardakli, 1/01, "Optical Techniques to Implement Networking Functions in Dynamically Reconfigurable Wavelength-Division-Multiplexed Fiber-Optic Communication Networks"
15. Olaf H. Adamczyk, 2/01, "Experimental Demonstration of Techniques to Improve System Performance in Fiber-Optic Communication Systems using Subcarrier-Multiplexed and Digital Baseband Signals"
16. Zhongqi Pan, 11/02, "Overcoming Fiber Dispersive Effects in High-Speed Reconfigurable Multi-Wavelength Optical Systems and Networks"
17. Asaf B. Sahin, 4/03, "Experimental Demonstration of Techniques to Improve System Performance in Non-Static Microwave Frequency Analog and Digital Signal Transmission over Fiber-Optic Communication Systems"

**Ph.D. THESES ADVISED AND GRANTED: (CONTINUED)**

18. Deniz Gurkan, 5/03, "Experimental Demonstrations of Optical Networking Functions for Wavelength-Division-Multiplexed (WDM) Optical Networks"
19. Yong-Won Song, 10/03, "Mitigation of Signal Degradations in Reconfigurable Wavelength-Division-Multiplexed Fiber-Optic Communication Systems"
20. S.M. Reza Motaghian Nezam, 4/04, "Chromatic and Polarization Mode Dispersion Monitoring for Equalization in Fiber-Optic Communication Systems"
21. Paniz Ebrahimi, 5/04, "Design and Implementation of Novel Optical Subsystems for Enhancing Spectral Efficiency, Security, and Performance of High-Speed Wavelength Division Multiplexed and Optical Code-Division-Multiple-Access Systems"
22. Lian-Shan Yan, 11/04, "Investigation of Degrading Effects and Performance Optimization in Long-Haul WDM Transmission Systems and Reconfigurable Networks "
23. John E. McGeehan, 5/05, "Experimental Demonstration of Optical Router and Signal Processing Functions in Dynamically Reconfigurable Wavelength-Division-Multiplexed Fiber Optic Networks"
24. Changyuan Yu, 8/05, "Dispersive and Nonlinear Effects in High-Speed Reconfigurable WDM Optical Fiber Communication Systems"
25. Yan Wang, 12/05, "Monitoring and Utilization of Dispersive and Nonlinear Effects in High-Speed Reconfigurable WDM Optical Fiber Networks"
26. Ting Luo, 2/06, "Management of Dispersion, Nonlinearity and Polarization-Dependent Effects in High-Speed Reconfigurable WDM Fiber Optic Communication Systems"
27. Saurabh Kumar, 11/06, "Optical Signal Processing For High-Speed, Reconfigurable Fiber Optic Networks"
28. Poorya Saghari, 11/06, "Techniques for Increasing the Number of Users in Dynamically Reconfigurable Optical Code Division Multiple Access Systems and Networks"
29. Louis C. Christen, 9/08, "Detection and Optical Signal Processing using Phase Based Optical Modulation Formats"
30. Bo Zhang, 12/08, "Nonlinear Optical Signal Processing For High-Speed, Spectrally Efficient Fiber Optic Systems and Networks"
31. Lin Zhang, 11/10, "Silicon Integrated Devices for Optical System Applications"
32. Scott R. Nuccio, 12/10, "Applications of All Optical Signal Processing for Advanced Optical Modulation Formats"
33. Irfan Fazal, 7/11, "Optical Signal Processing for Enabling High-Speed, Highly Spectrally Efficient and High Capacity Optical Systems"
34. Jeng-Yuan Yang, 9/11, "Optical Performance Monitoring and Signal Processing to Enable Robust and Reconfigurable Optical Networks"
35. Xiaoxia Wu, 10/11, "High-Speed Optical Signal Processing and Performance Monitoring Towards Tbit/s Optical Networks"

**Ph.D. THESES ADVISED AND GRANTED: (CONTINUED)**

37. Omer Yilmaz, 12/11, "Advanced Nonlinear Optical Signal Processing Techniques For High Speed, Reconfigurable Optical Fiber Networks"
38. Yang Yue, 10/12, "Integrated Silicon Waveguides and Specialty Optical Fibers for Optical Communications System Applications"
39. Salman Khaleghi, 6/13, "High-Speed and Reconfigurable All-Optical Signal Processing for Phase and Amplitude Modulated Signals"
40. Reza Chitgarha, 6/14, "Reconfigurable High-Speed Optical Signal Processing and High-Capacity Optical Transmitter"
41. Hao Huang, 11/14, "Multiplexing Techniques and Reconfigurable Networking Functions for Optical Communications using OAM Beams"
42. Asher Voskoboinik, 12/14, "Sweep-Free Brillouin Optical Time-Domain Analyzer"
43. Nisar Ahmed, 1/16, "Orbital Angular Momentum based Spatially Multiplexed Optical and Millimeter-wave Communications"
44. Yan Yan, 4/16, "High Capacity Optical and RF/mm-wave Communications Utilizing Orbital Angular Momentum Multiplexing"
45. Yongxiong Ren, 11/16, "Orbital Angular Momentum-Based Space Division Multiplexing for High-Capacity Optical and Millimeter-Wave Communications"
46. Morteza Ziyadi, 01/17, "Reconfigurable High-Speed Optical Signal Processing Using Optical Frequency Comb for High-Capacity, Spectrally Efficient Fiber Optic Systems and Networks"
47. Guodong Xie, 12/17, "Using Waves Carrying Orbital Angular Momentum for Communications and Remote Sensing"
48. Changjing Bao, 12/17, "On-Chip Kerr Frequency Comb Generation and Its Effects on the Application of Optical Communications"
49. Ahmed Almainan, 4/18, "Optical Wave Mixing for Tunable Delays and High-Speed Signal Processing"
50. Amirhossein Mohajerin Ariaei, 5/18, "Reconfigurable High-Speed Processing and Noise Mitigation of Optical Data"
51. Long Li, 02/19, "Applications of Orbital Angular Momentum in High-Capacity Free-Space Optical Communications"
52. Yinwen Cao, 04/19, "Reconfigurable Optical Signal Processing for Efficient Spectrum Utilization in High-speed Optical Communication Systems"
53. Peicheng Liao, 11/19, "Microresonator-based Kerr Frequency Comb for Optical Communications and Signal Processing"
54. Zhe Zhao, 07/20, "Optical and mm-wave Orbital-angular-momentum Beam Generation and its Applications in Communications"
55. Cong Liu, 03/21, "Applications in Optical Communications: Quantum Communication Systems and Optical Nonlinear Devices"

**Ph.D. THESES ADVISED AND GRANTED: (CONTINUED)**

56. Ahmad Fallahpour, 03/21, “Reconfigurable High-Speed Optical Signal Processing for Optical Communication and Modulation Format Manipulation”
57. Fatemeh Alishahi, 09/21, “Reconfigurable and Flexible High-Speed Optical Signal Processing and Spectrally Shared Optical Subsystems”
58. Kai Pang, 3/22, “Spatial Modes for Optical Communications and Spatiotemporal Beams”
59. Runzhou Zhang, 4/22, “High-Capacity Optical Communications Using Structured Light in Random and Disturbed Media”
60. Haoqian Song, 4/22, “Using Spatial Modes for Data Transmission Through the Air and Through the Air-Water Interface”

**GRANTS:**

**National Science Foundation (NSF) Young Investigator Award (9/92-8/94), PI,**  
"Optical Fiber Communication Systems"

**Advanced Research Projects Agency (ARPA) (8/93-7/96), Co-PI,** "Two-Dimensional WDM Interconnects for Highly Parallel and Dense High-Speed Optical Processing", with C.J. Chang-Hasnain (Stanford Univ.)

**Charles Lee Powell Foundation USC New Investigator Award (1/92-6/94), PI,**  
"WDM Amplified Optical Networks"

**ILX Lightwave Corp. (10/92), University Donations Program Award, PI,**  
"WDM Systems Research using Wavelength-Tunable Lasers"

**National Science Foundation (NSF) (9/93-8/96), Co-PI,** "Wavelength Converting and Wavelength Routing for High-Efficiency Almost-All-Optical Networks," with V.O.K. Li and P.D. Dapkus (USC)

***(Proposal ranked #1 out of 70 letters-of-intent and 33 final proposals)***

**David and Lucile Packard Foundation (10/93-9/99), PI,** "Fellowship in Science and Engineering: WDM Optical Communications"

**Advanced Research Projects Agency (ARPA) (8/94-7/96), Co-PI,** "Optically-Amplified Scalable WDM Networks using Acousto-Optic Filters for Amplifier Gain Equalization and Signal Routing," with D.A. Smith (Case Western Reserve) and Kathryn D. Li (New Focus)

**National Science Foundation, Presidential Faculty Fellows Award (9/94-8/97), PI,**  
"High-Capacity WDM Optical Communication Systems"

**ILX Lightwave Corp. (4/95), University Donations Award, PI,** "WDM Systems using Multi- $\lambda$  VCSELs"

**Ballistic Missile Defense Org., Focused Research Initiative (5/95-5/98),**  
"Multiscale Photonic Data Fusion Networks and Their Interfaces," **Senior Investigator** (PI - A.A. Sawchuk)

**Optoelectronics Industry Development Assoc. / Joint Optoelectronics Project (OIDA/JOP) (2/96), PI,**  
"Ultra-High-Capacity WDM Switching Systems"

**Defense Univ. Research Instrumentation Program (DURIP / ARPA) (5/96), Co-PI,** "Transparent High-Speed Optically-Amplified Multiple-Wavelengths Networks using AOTFs for Add/Drop Multiplexing and Gain Equalization", with D.A. Smith (Case Western Reserve Univ.)

**National Science Foundation (NSF) 7/96-6/06,** "Multiwavelength Switching in High-Capacity Media Systems," Engineering Research Center in Integrated Media Systems, **Key Investigator** (PI - C.L. Nikias)

**Defense Advanced Research Projects Agency (DARPA) (9/96-8/99), Co-PI,** "Novel WDM Device and System Research for Ultra High Capacity Optical Interconnects", with C.J. Chang-Hasnain (UC Berkeley)

**National Science Foundation (NSF) 8/96-7/97, Co-PI,** Instrumentation Grant,  
"Wired and Wireless High-Speed Networks," with R.A. Scholtz and J. Choma (USC)

**National Science Foundation (NSF) 7/96-6/97, Co-PI,** with L.A. McAdams (Optivision, Inc.), Small Business Technology Transfer (STTR) Program, "Novel Wavelength Shifting Structures for Optical Networks,"

**GRANTS: (CONTINUED)**

**Joint Services Electronics Program (JSEP)** (4/97-3/00), **Senior Investigator** (PI - W. Steier, USC), "Ultra-High-Speed Wavelength and Time Switching for Bursty Communications"

**Defense Advanced Research Projects Agency (DARPA)** (9/97-8/00), **Senior Investigator** (PI - S.R.J. Brueck, Univ. of New Mexico), "Optoelectronic Materials Center for Manufacturable, Multi-dimensional High Capacity Optoelectronic Interconnects"

**Defense Univ. Research Initiative Program (DURIP/ DARPA)** (5/98-4/99), **Co-PI**, "2D VCSEL Arrays for Optical Imaging, Interconnects, and Signal Processing," with C. Chang-Hasnain (UC Berkeley)

**Defense Advanced Research Projects Agency (DARPA)** (6/98-5/01), **PI**, "Using a Recirculating Fiber Loop to Determine the Limitations Placed on Ultra-High-Performance Soliton and Linear Optical Systems by Polarization Mode Dispersion," Next Generation Internet

**National Science Foundation (NSF)** (9/98-8/01), **Co-PI**, "Rapidly-Tunable Integrated Vertical Cavity Filters and Attenuators For Dynamically Reconfigurable Packet-Switched WDM Optical Networks," with C. Chang-Hasnain (UC Berkeley)

**Optoelectronics Industry Development Assoc. / Joint Optoelectronics Project (OIDA/JOP)** (2/98), **PI**, "Ultra-High-Capacity WDM Networks"

**Charles Lee Powell Foundation** (7/98-6/01), **PI**, "Photonics Backbone for Wireless Communications"

**ILX Lightwave Corp.** (6/00), **University Donations Program Award**, **PI**, "WDM Systems Research for the Next Generation Internet"

**Defense Advanced Research Projects Agency (DARPA)** (7/00-6/04), **Senior Investigator** (PI - S.R.J. Brueck, Univ. of New Mexico), "Optoelectronic Materials Center for High Capacity Optoelectronic Interconnects"

**Department of Defense** (6/99-5/01), **PI**, "Compensation of Channel-Degrading Effects in Reconfigurable WDM Systems"

**Hitachi Corporation** (10/99-6/01), **PI**, "Compensation of Polarization Mode Dispersion"

**Phaethon Communications** (10/00-11/02), **PI**, "Studies of Optical-Fiber-Induced Dispersion Effects"

**Defense Advanced Research Projects Agency (DARPA)** (6/00-5/03), **PI**, "Tunable Compensation of Chromatic- and Polarization-Dispersion Effects for Enabling Significantly Higher Performance in the BOSSNET and NTON SUPERNET Testbeds," Next Generation Internet Program

**The Okawa Foundation** (10/00-9/01), **PI**, "Ultra-High-Capacity Multi-Wavelength Optical Systems"

**Intel Corporation** (12/01-11/02), **PI**, "New Technologies for Internet Routing in All-Optical Networks "

**National Science Foundation (NSF)** (10/00-9/03), **PI**, "Novel Dispersion-Division-Multiplexing Technique for Enabling Double the Spectral Efficiency in Transmission & Routing of Photonic & Microwave Networks"

**National Science Foundation (NSF)** (10/00-9/03), **Co-PI**, "Vertically-Integrated Primitives for a Bufferless All-Optical Packet-Switched Network," with C. Chang-Hasnain and V. Anantharam (UC Berkeley)

**GRANTS: (CONTINUED)**

**Defense Advanced Research Projects Agency (DARPA)** (6/00-5/03), **Co-PI**, "Programmable Miniaturized Devices for CDMA WDM Systems," Chip-Scale WDM Program (PI - D.A.B. Miller, Stanford University)

**Defense Advanced Research Projects Agency (DARPA)** (6/00-5/03), **Co-PI**, "Microresonator and Photonic Crystal Filters, Lasers and Modulators for Analog and Digital Chip Scale WDM Systems," Chip-Scale WDM Program, (PI - P.D. Dapkus and J. O'Brien, USC)

**JDS Uniphase Corporation** (3/02), **PI**, "Equipment Donation for the Optical Communications Lab at USC"

**Cisco Systems** (9/03-8/04), **PI**, "Mitigation of Fiber Nonlinear Effects in PMD-Limited WDM Systems"

**Virtual Photonics Inc.** (5/03), **PI**, "Software Donation for the Optical Communications Lab at USC"

**Defense Advanced Research Projects Agency (DARPA)** (12/02-11/06), **PI**, "Secure Communications Over LANs using O-CDMA," OCDMA Program

**Intel Corporation** (1/03-12/04), **PI**, "Optical Buffers for Enhancing Optical Burst Switching"

**Cisco Systems** (9/04-8/05), **PI**, "Analysis of the Transmission Limitations of Directly Modulated Digital Signals in Metropolitan Optical Communication Systems"

**Missile Defense Agency** (10/03-9/04), **Co-PI**, "Measurements of Thin-Film Waveguides" (PI – Boyd Hunter, TPL, Inc.)

**National Science Foundation (NSF)** (9/03-8/06), **PI**, "High-Capacity Optical Communication Networks: Device and Systems Research using Photonic Crystal Structures that Enable Highly-Advanced Classical and Quantum Optical Networking," with A. Scherer (Caltech)

**Defense Advanced Research Projects Agency (DARPA)** (7/04-6/08), **Senior Investigator** (PI - S.R.J. Brueck, Univ. of New Mexico), "Optoelectronic Materials Center for Spatial, Temporal and Spectral Localization for Advanced Photonic Capabilities," University Photonics Research Program

**Defense Advanced Research Projects Agency (DARPA)** (4/04-10/05), **PI**, "DOD-N Network Performance Based on Specific Physical DOD-N Technology Parameters: Connecting Multiple Core Routers," DOD-N Program

**Defense Advanced Research Projects Agency (DARPA)** (7/04-9/08), **Co-PI** (PI – R.W. Boyd, Univ. of Rochester), "Applications of Slow Light in Optical Fibers," Slow Light Program

**Intel Corporation** (5/05-12/05), **PI**, "Measurements of Silicon-Based Photonic Filters"

**Cisco Systems** (9/05-8/06), **PI**, "Systems Measurements and Demonstrations of Cost-Effective Reach Extension and Monitoring using Intel-Fabricated Silicon-Based Waveguide Grating Filters"

**National Science Foundation (NSF)** (9/05-8/09), **Senior Investigator**, "NIRT: Integrated Nanophotonics for Quantum Computation and Quantum Information Processing" (PI – J.D. O'Brien, USC)

**Hewlett Packard Corporation** (10/05-1/06), **PI**, "Optical Interconnections"

**Intel Corporation** (1/06-12/06), **PI**, "Link Studies of Silicon Photonic Devices"

**GRANTS: (CONTINUED)**

**National Science Foundation (NSF)** (9/06-8/09), **Co-PI**, "A Hybrid Integrated Bidirectional Transparent RF-Optical Interface for Heterogeneous Data Traffic" (PI – H. Hashemi, USC)

**Defense Advanced Research Projects Agency (DARPA)** (10/06-7/07), **Co-PI** (PI – R. Beausoleil, Hewlett Packard), "Applications of Nanophotonics to Information Technology," Intra-Chip Communications Program (ARL)

**Defense Advanced Research Projects Agency (DARPA)** (7/07-6/08), **PI**, "Cisco: Variable-Bit-Rate and Multiple-Modulation Format DQPSK/ASK Receivers," Industrial Matching Program for the University Photonics Research Program

**Cisco Systems** (7/07-6/08), **PI**, "Techniques for Enhancing WDM Transmission Performance when using Advanced Modulation Formats at 40 Gb/s and Beyond"

**Defense Advanced Research Projects Agency (DARPA)** (7/07-6/08), **PI**, "Intel: Phase and Amplitude Response of Silicon Modulators for Optical Systems," Industrial Matching Program for the University Photonics Research Program

**Intel Corporation**, (7/07-6/08), **PI**, "Phase and Amplitude Response of Silicon Modulators for Optical Systems"

**Optoelectronics Industry Development Association (OIDA)**, (11/07-3/08), **PI**, "High-Speed Optical Modulators," Photonics Technology Access Program (PTAP)

**National Institute of Standards and Technology (NIST)**, (10/07-9/08), **PI**, "Optical Performance Monitoring to Enable Robust and Reconfigurable Optical Networks," Research Grants Program

**Defense Advanced Research Projects Agency (DARPA)** (1/08-12/10), **Co-PI** (PI – Ann C. Von Lehman, Telcordia), "Dynamic Resilient Terabit IP/Optical Networks," CORONET Program

**Defense Advanced Research Projects Agency (DARPA)** (1/08-6/12), **PI**, "Enhanced Performance & Functionality of Continuously-Tunable Optical Delays," POPS Program

**Hewlett Packard Corporation** (5/08-9/08), **PI**, "Micro-ring Resonators for Optical Interconnections"

**Defense Security Cooperation Agency (DSCA)** (8/09-7/11), **PI**, "Enabling Higher-Performance Nonlinearity-Based Optical Sensors: Advances in Sensitivity and Dynamic Behavior "

**Defense Univ. Research Instrumentation Program / Air Force Office of Scientific Research (DURIP/AFOSR)** (6/08-5/09), **PI**, "A 100-Gbit/s Base Multiplexer for Generation and Transmission of 400-Gbit/s Optical Polarization-Multiplexed Differential Quadrature Phase-Shift-Keying Signals"

**Defense Advanced Research Projects Agency (DARPA)** (6/08-5/09), **PI**, "Exploring Signal Distortion in an Ultra-Low-Loss Waveguide," iPhOD Program

**Defense Advanced Research Projects Agency (DARPA)** (9/08-8/09), **Co-PI** (PI – A.L. Gaeta, Cornell Univ.), "Large Tunable Delays in Fiber and On-Chip via Conversion/Dispersion," Slow Light Program

**Hewlett Packard Corporation** (8/08-7/09), **PI**, "Signal Processing in On-Chip Optical DWDM Networks," HP Labs Innovation Research Program (IRP)

**GRANTS: (CONTINUED)**

**Defense Advanced Research Projects Agency (DARPA)** (11/08-10/09), **Co-PI** (PI – Ann C. Von Lehman, Telcordia), "Data in the Optical Domain Networks (DOD-N) Enabling Technology Transition," DOD-N Program

**National Science Foundation (NSF)** 9/08-8/13, "Center for Integrated Access Networks (CIAN)," Engineering Research Center, **Thrust Leader** (PI - Nasser Peyghambarian, Univ. of Arizona)

**Hewlett Packard Corporation** (8/09-7/10), **PI**, "Signal Processing in On-Chip Optical DWDM Networks II," HP Labs Innovation Research Program (IRP)

**Defense Advanced Research Projects Agency (DARPA)** (11/09-5/14), **Co-PI**, "Ultra-low Loss, Chip-Based Hollow-Core Waveguide using High-Contrast Grating," integrated Photonic Delay (iPhoD) Program (PI: C.J. Chang Hasnain, UC Berkeley)

**Gigoptix Corp.** (11/09-10/10), **PI**, "High-Speed Modulation in Optical Communication Systems"

**Hewlett Packard Corporation** (8/10-7/11), **PI**, "Signal Processing in On-Chip Optical DWDM Networks III," HP Labs Innovation Research Program (IRP)

**Defense Advanced Research Projects Agency (DARPA)** (6/10-4/11), **PI**, "Optical Tapped-Delay-Line High-Speed Signal Processing," MTO Study

**Cisco Systems** (10/09-9/10), **PI**, "Novel Techniques to Enhance the Capacity Planning and Resource Management Efficiency of High-Capacity Optical Networks," Univ. Research Program

**Defense Advanced Research Projects Agency (DARPA)** (9/10-8/13), **Co-PI**, "The Ultimate Capacity-Achieving Receiver for Classical Optical Communications," Information on a Photon (InPho) Program (PI: S. Dolinar, JPL)

**National Science Foundation (NSF)** (11/11-10/16), **Co-PI**, Major Instrumentation Grant (MRI), "Development of Measurement and Testing Equipment for Distributed Wireless Communications," with A. Molisch (PI, USC).

**Defense Univ. Research Initiative Program (DURIP/ONR)** (12/11-11/12), **Co-PI**, "Ultra-wideband MIMO Channel Sounder for Distributed Electronic Warfare Applications and Localization Systems," with A. Molisch (PI, USC)

**Cisco Systems** (10/11-9/12), **PI**, "Flexible, Reconfigurable Capacity Output of High-Performance Optical Transceivers Enabling Cost-Efficient, Scalable Network Architectures," Univ. Research Program

**Defense Security Cooperation Agency (DSCA)** (2/1/2012-1/31/2013), **PI**, "Performance Enhancement of Optical Fiber Sensors Based on Nonlinearities and Multi-Dimensional Parameterization"

**Gigoptix Corp.** (11/10-10/11), **PI**, "100-Gbaud Modulation in Optical Communication Systems"

**Defense Advanced Research Projects Agency (DARPA)** (2/11-2/12), **PI**, "High-Speed Optical Processing of Sparse Aperture Image Data (50 Megapixels, 10-bit Depth) using Tunable Optical Tapped-Delay-Lines," MTO/STO Study

**Google Faculty Research Awards Program** (11/11-10/12), **PI**, "Cost-Effective, Ubiquitous Optical SNR Performance Monitoring to Enhance Stability and Reconfigurability in Advanced, High-Capacity Google Networks"

**GRANTS: (CONTINUED)**

**Defense Advanced Research Projects Agency (DARPA)** (6/12-1/14), **PI**, "Reconfigurable Networking Functions (Add/Drop, Data Exchange, Multicasting) in OAM-Based Systems," DSO Study

**National Science Foundation (NSF)** (3/2012-3/2015), **PI**, "Terabit-per-second Data Processing to Extract Features of Interest in Enormous Amount of Data"

**Air Force Office of Scientific Research (AFOSR)** (7/12-7/15), **PI**, "Tailoring of Dispersion and Nonlinearity of Slotted Waveguides and Ring Resonators to Achieve Stable, Efficient, Octave-Spanning Optical Frequency Combs," Basic Research Initiative (BRI) Program

**Intel Labs University Research Office (URO)** (12/12-12/15), **Co-PI**, "Higher, Denser, Wilder: Massively Broadband and Adaptive Wireless for 5th Generation Wireless Communications" (PI: A. Molisch, USC)

**Google Faculty Research Awards Program** (1/13-12/13), **PI**, "Reconfigurable, Ubiquitous Optical Signal-to-Noise-Ratio Monitoring to Enhance Stability and Upgradability in Google's Present and Future High-Capacity Networks"

**National Science Foundation (NSF)** (9/13-8/15), "Center for Integrated Access Networks (CIAN)," Engineering Research Center, **Thrust Leader** (PI - Nasser Peyghambarian, Univ. of Arizona)

**National Science Foundation (NSF)** (10/13-9/16), **Co-PI**, INSPIRE Program, "An Optical Turing Machine for Native Computing using High-Capacity Transmission Modulation Format Symbols" (PI: Joe Touch, USC ISI)

**Nxgen Partners** (5/14-8/15), **PI**, "Application of Orbital Angular Momentum to Communications"

**Bandwidth10** (5/14-7/15), **PI**, USC-1347563, NSF, Option 1: Small-Business ERC Collaborative

**Air Force Office of Scientific Research (AFOSR)** (12/14-6/15), **Co-PI**, "Terabit Optical COMMunications System (TOCOMM)," STTR Program

**Air Force Office of Scientific Research (AFOSR)** (6/15-6/19), **PI**, "Fundamental Understanding of the Physics of Kerr Frequency Comb and Its Effects on the Applications of Coherent Communication, Signal Processing and Measurement"

**Defense Security Cooperation Agency (DSCA)** (11/15-1/16), **PI**, "Tunable Discrete Random Access Optical Buffer"

**Defense Security Cooperation Agency (DSCA)** (11/15-11/16), **PI**, "Generic Fabrication Methodology for VIS-IR Integrated Electrooptical Circuits"

**Fujitsu** (4/15-4/16), **PI**, "Optical Signal Processing Functions in an Optical Network"

**National Institute of Standards and Technology (NIST)** (2/16-1/17), **PI**, "Measurement, Technology, and Analysis of Overlapped Channels for the Optimal Use of Spectrum in Communication Systems"

**NxGen Partners** (12/15-8/16), **PI**, "Using OAM Beams for High-capacity RF E-band & Optical Fiber km Links"

**Air Force Office of Scientific Research (AFOSR)** (3/16-2/18), **Co-PI**, "Phase II, The Terabit Optical COMMunications (TOCOMM) System" (PI: Robert Bock, R-Dex)

**GRANTS: (CONTINUED)**

**National Science Foundation (NSF)** (6/15-5/18), **Co-PI**, “Fundamentals of Wireless Communication Systems using Orbital Angular Momenta” (PI: Andreas F. Molisch)

**Office of Naval Research (ONR)** (7/15-7/18), **Co-PI**, “High-Capacity, Free-Space Quantum Key Distribution based on Spatial and Polarization Encoding” (PI: Robert Boyd, University of Rochester)

**Office of Naval Research (ONR)** (10/15-6/16), **Co-PI**, “STTR: Precision Optical Navigation Guidance (PRONG) System” (PI: D. Starodubov, FOMS, Inc.)

**Huawei / Futurewei** (2/16-2/18), **PI**, “Optical Signal Processing for All-Optical Networks”

**Intel Labs** (2/16-2/19), **PI**, “OAM-Based Wireless Systems”

**Defense University Research Instrumentation Program (DURIP)** (07/16-06/17), **PI**, “High Baud-Rate and High-Order QAM Optical Transmitter for Long-Range Terabit-per-Second Free-Space Optical Communications Using Orbital Angular Momentum”

**National Science Foundation (NSF)** (07/16-03/17), **Co-PI**, “STTR Phase I: TeraLink - Next Generation Free Space Optical Communications System”

**Huawei / Futurewei** (7/16-7/17), **PI**, “Perspectives on the Future of Optical Communications”

**Vannevar Bush Faculty Fellowship (VBFF)** (08/16-07/21), **PI**, “Multiple Structured Electromagnetic Waves Containing Orbital Angular Momentum for Novel Communications, Imaging, and Directed Energy”

**Fujitsu** (4/17-9/18), **PI**, “Insights for Future Optical Communication Systems”

**Lyteloo Technologies**, (11/17), “Equipment donation (spatial light modulator)”

**Air Force Office of Scientific Research (AFOSR) SBIR** (01/18-03/19), **Co-PI**, "The Tunable and Reconfigurable Integrated Platform (TRIP) for OAM Generation, Multiplexing, Demultiplexing and Detection" (PI: Robert Bock, R-Dex)

**Fujitsu** (04/18-04/19), **PI**, “Optical Signal Processing”

**Naval Air Systems Command (NAVAIR) SBIR** (06/18-12/18), **Co-PI**, "Enhanced Robustness and Reliability for Free-Space Optical Communication Link Using Spatial Diversity (SD-Link)" (PI: Robert Bock, R-Dex)

**Defense Advanced Research Projects Agency (DARPA)** (7/18-6/22), **Co-PI**, "Giant Nonlinear Response of ENZ Metastructures" (PI: Robert Boyd, University of Rochester)

**Air Force Office of Scientific Research (AFOSR) SBIR** (12/19-12/21), **Co-PI**, "Phase II: The Tunable and Reconfigurable Integrated Platform (TRIP) for OAM Generation, Multiplexing, Demultiplexing and Detection" (PI: Robert Bock, R-Dex)

**Defense University Research Instrumentation Program (DURIP)** (04/20-04/21), **PI**, “Signal Source Analyzer for Frequency Comb, Orbital Angular Momentum Applications, and Highly Nonlinear Materials”

**Naval Information Warfare Center (NIWC)** (07/20-01/21), **PI**, “Physics Based Propagation Modeling for OAM Multiplexed Optical Communication Links”

**GRANTS: (CONTINUED)**

**Office of Naval Research under a Multidisciplinary University Research Initiative (MURI)** (06/20-06/25), **Co-PI**, “High Photon Density Spatiotemporal (OAM+SAM) Vector Beams for Maritime Environments” (PI: E. Johnson, Clemson University)

**Office of Naval Research under a Multidisciplinary University Research Initiative (MURI)** (07/20-07/25), **Co-PI**, “Classical Entanglement in Structured Optical Fields” (PI: A. Abouraddy, Univ. of Central Florida)

**Defense Security Cooperation Agency (DSCA)** (07/2020-07/21), **PI**, “High-Capacity Data Transmission Link Between a Ground Terminal and a Flying Drone using Multiplexing of Multiple Optical Orbital-Angular-Momentum Beams”

**Defense Security Cooperation Agency (DSCA)** (06/2020-06/21), **PI**, “Enhancing the Utilization of Structed Beams for Localization and Hiding by Diversity and Compensating Turbulence Effects”

**Nippon Telephone and Telegraph (NTT)** (07/20-07/21), **PI**, “Experimental Implementation of a High-Capacity Wireless Link by Exploiting Orbital Angular Momentum Modes Multiplexing in the Sub-THz Regime”

**Defense Advanced Research Projects Agency (DARPA)** (07/20-07/21), **Co-PI**, “Scalable All-Optical Processing – Remotely (SCALOP-R)” (PI: J. Habif, USC ISI)

**Airbus Institute for Engineering Research (AIER) Board** (09/20-09/22), **PI**, “Towards Terabit/sec High-Capacity Free-Space Optical Communication Links to Airplanes using Multiplexing of Orthogonal Beams”

**Qualcomm Innovation Fellowship** (9/20-10/21), **Supervisor**, “High-Capacity Mode-Division-Multiplexed Wireless Communications Within and Beyond Millimeter-Wave Band”

**Air Force Research Laboratory (AFRL) though University of New Mexico COSMIAC** (9/2021-9/2023), **PI**, Subaward on Program “Communications and Position Navigation and Timing (PNT) (COMPNT)”

**Airbus Institute for Engineering Research (AIER) Board** (09/22-09/24), **PI**, “Utilizing Structured Light to Enable Both 3D Probing of Turbulence and Resilient High-Capacity Communications Through Turbulence”

**Office of Naval Research (ONR) STTR** (06/22-12/22), **Co-PI**, "Phase I: Structured-Light-Based High-Resolution and High-Dynamic-Range Optical Underwater Ranging" (PI: Robert Bock, R-Dex)

**Defense Advanced Research Projects Agency (DARPA)** (9/22-9/23), **Co-PI**, "Space-Based Adaptive Communications Node" (PI: Keren Bergman, Columbia University)

**Defense Advanced Research Projects Agency (DARPA)** (4/22-4/24), **Co-PI**, "DIAMOND: Distributed Training of Massive Models at Bandwidth Frontiers" (PI: Jonathan Habif, USC ISI)

**USC ACTIVITIES:**

Member, Proposal Review Committee, Energy Frontier Research Center Program, USC Office of VP Research ('22)  
Member, University Research Network ('22)

**Chair**, Teaching & Service Subcommittee, Merit Review Committee, Dept. of ECE-Systems ('22)

Member, Natural Sciences/Engineering Panel, University Committee on Appointments, Promotions, and Tenure (UCAPT) ('21-'23)

Member, Review Committee, Vice President of Research, USC Nominations for Packard Fellowships in Science & Engineering ('21-'22)

Member, Provost's USC Decanal Review Advisory Committee of Dean Yortsos ('21)

Member, ECE Merit Review Committee (Teaching) ('21)

Member (VSoE Committee) and Chair (ECE-S, Subcommittee), Covid-19 Research Restart Task Force, VSoE ('20)

Member, USC VSoE Space Council ('19-'20)

Member, Award Committee, Associates Award for Creativity in Research (several years within '13-'19)

**Director**, Communications Sciences Institute, Ming Hsieh Dept. of Electrical Eng. ('16-'17)

Faculty Advisor, IEEE, USC Student Chapter ('15-'18)

Faculty Advisor, OSA Student Chapter at USC ('14-'18)

Member, Graduate Curriculum Committee, Ming Hsieh Dept. of Electrical Engineering – Systems ('16-'17)

**Chair**, Provost's University-Wide Committee on Academic Review (UCAR) (2013-2015)

**Co-Chair**, Provost's University-Wide Committee on Academic Review (UCAR) (2012-2013)

**Chair**, Provost's University-Wide Ph.D. Fellowship Evaluation Task Force (2011-2012)

**Chair**, Provost's University-Wide Graduate School Committee, Fellowships, Prizes & Awards ('09-'11)

**President**, USC Chapter of Phi Kappa Phi All-University Honor Society ('11-'12)

**Vice President**, USC Chapter of Phi Kappa Phi All-University Honor Society ('10-'11)

Executive Board Member, USC Chapter of Phi Kappa Phi All-University Honor Society ('09-'12)

Member, Provost's Advisory Committee on Transformational Hiring in Sciences & Eng. ('11-'12)

Member, Vice-Provost's The Graduate School Faculty Advisory Council (2011-2012)

Faculty Advisory Committee, USC Viterbi School of Eng., New Frontiers of Science & Eng. Bldg. ('10)

Provost's Conflict of Interest in Research Committee ('07-'08, '08-'09, '09-'10)

Provost's Conflict of Interest in Research Task Force ('10-'11)

Member, Award Committee, Associates Award for Excellence in Teaching (several years within '04-'09)

Provost's Faculty Working Group for "Defining the New Diploma in Ph.D. Innovation" ('08-'09)

Provost's Graduate School Committee on Fellowships, Prizes, and Awards ('07-'08, '08-'09)

Member, Dean's Committee of the Unification of the Ming Hsieh EE Dept., USC Viterbi School of Eng. ('10)

Executive Committee, Ming Hsieh Dept. of Electrical Engineering - Systems ('07-'11 and '16-'17)

**Co-Director**, Communications Sciences Institute, Ming Hsieh Dept. of Electrical Eng. ('07-'11)

Academic Program Review Subcommittee, Ming Hsieh Dept. of EE Advisory Board Committee ('10)

Student Affairs Committee of the USC Board of Trustees, Faculty Member ('06-'07)

Organizer, Students' Practical Guide Seminar Series, Ming Hsieh Dept. of Electrical Eng. ('07-'09)

Co-Chair, Departmental Retreat Committee, Ming Hsieh Dept. of Electrical Eng. ('07)

Member, Awards Committee, Ming Hsieh Dept. of Electrical Eng. ('07-'08, '08-'09, '11-'12)

Member, Research Committee of the Engineering Faculty Council, USC Viterbi School of Eng. ('07)

USC Center for Excellence in Teaching (CET), Teaching Assistant Training Program ('06)

University-Wide Committee on Appointments, Promotions, & Tenure (UCAPT) ('03-'04, '04-'05, '08-'10)

**USC ACTIVITIES: (CONTINUED)**

Provost's University Financial Disclosures Review Committee ('03-'04, '04-'05, '05-'06, '06-'07)  
Committee, University-Wide Associates Awards, Excellence in Teaching & Outstanding TA ('03-'05,'07-'10)  
Faculty Advisor, Alpha Delta Sigma, USC Jewish Honor Campus Fraternity  
Nominated and Accepted, Provost's Leadership Council ('97-'98)  
USC Department of Electrical Engineering – Systems, Chair Search Committee ('02-'03)  
Chair, Best Student Research Paper Award Committee, Dept. of Electrical Engineering ('02)  
Director's Search Committee, USC's NSF Engineering Research Center in Multimedia ('01-'02)  
USC School of Engineering Dean's Search Committee ('00-'01)  
USC School of Engineering Research Committee ('99-'00)  
Elected, USC Engineering Appointments, Promotions, & Tenure Committee ('94-'98)  
Associate Director, USC Integrated Media Systems Center, Student Affairs ('96-'01)  
University Committee on Patents and Technology ('94-'97)  
Associate Director, USC Center for Photonic Technology ('94-present)  
USC School of Engineering Restructuring Subcommittee ('96)  
USC School of Engineering Systems Architecting Committee ('97)  
USC School of Eng. Recruitment Enrollment Management Committee ('94-'96)  
Faculty Advisor, Optical Society of America, USC Student Chapter ('95-present)  
Board of Directors, LA Hillel City Board, USC Representative ('95-'97)  
Faculty Advisory Board, USC Hillel Organization ('92-'99)  
Seminar Series Coordinator (Communications Sciences Institute) ('92-'95)  
Ph.D. Screening Exam Coordinator (Communications Sciences Institute) ('92-'97)

## **PUBLICATIONS**

### **U.S. PATENTS: (non-U.S. patents not listed here)**

1. Title: A Method of Localized Photochemical Etching of Multilayered Semiconductor Body (U.S. Pat. Ser. No. 5,081,002), Co-Inventors w/ A.E. Willner: M. N. Ruberto, D. V. Podlesnik, and R. M. Osgood, Jr. (Jan. 14, 1992)
2. Title: One-To-Many Simultaneous Optical Two-Dimensional Plane Interconnections using Multiple Wavelength, Vertical Cavity, Surface-Emitting Lasers and Wavelength-Dependent Detector Arrays (U.S. Pat. Ser. No. 5,546,209), Co-Inventors w/ A.E. Willner: C.J. Chang-Hasnain and J.E. Leight. (Aug. 13, 1996)
3. Title: Tunable Dispersion Compensator Based on a Nonlinearly-Chirped Fiber Bragg Grating (U.S. Pat. Ser. No. 5,982,963), Co-Inventors w/ A.E. Willner: J.-X. Cai, J. Feinberg, K.-M. Feng, V. Grubsky, and D.S. Starodubov. (Nov. 9, 1999)
4. Title: Integrated Bi-directional Gradient Refractive Index Multiplexer (U.S. Pat. Ser. No. 6,011,885), Co-Inventors w/ A.E. Willner: J.R. Dempewolf, R.H. Dueck, B.V. Hunter, and R.K. Wade. (Jan. 4, 2000)
5. Title: Dispersion Compensation by using Tunable Nonlinearly Chirped Gratings (U.S. Pat. Ser. No. 6,330,383), Co-Inventors w/ A.E. Willner: J.-X. Cai, K.-M. Feng, R. Khosravani, S. Lee, and J. Peng. (Dec. 11, 2001)
6. Title: Optical Compensation for Dispersion-Induced Power Fading in Optical Transmission of Double-Sideband Signals (U.S. Pat. Ser. No. 6,388,785), Co-Inventors w/ A.E. Willner: O.H. Adamczyk, S.A. Havstad, A.B. Sahin, and Y. Xie. (May 14, 2002)
7. Title: Tunable Compensation for Polarization-Mode Dispersion using a Birefringent Nonlinearly-Chirped Grating in a Dual-Pass Configuration (U.S. Pat. Ser. No. 6,400,869), Co-Inventors w/ A.E. Willner: S. Lee, Z. Pan, and Y. Xie. (June 4, 2002)
8. Title: Dynamic Power Equalization of Many Wavelength-Division-Multiplexed Channels in a Fiber Optic System using Acousto-Optic Technology (U.S. Pat. Ser. No. 6,341,021), Co-Inventors w/ A.E. Willner: J.-X. Cai, K.-M. Feng, S.H. Huang, D.A. Smith, and X.Y. Zou. (Jan. 22, 2002) [*Note: Name misspelled as "Wilner" in patent.*]
9. Title: Tunable Optical Dispersion-Slope Compensation Based on a Nonlinearly-Chirped Bragg Grating (U.S. Pat. Ser. No. 6,453,093), Co-Inventors w/ A.E. Willner: S. Lee, Z. Pan, and Y. Xie. (Sept. 17, 2002)
10. Title: Tuning of Optical Dispersion by using a Tunable Fiber Bragg Grating (U.S. Pat. Ser. No. 6,453,095), Co-Inventors w/ A.E. Willner: J.-X. Cai, J. Feinberg, K.-M. Feng, V. Grubsky, and D.S. Starodubov. (Sept. 17, 2002)
11. Title: Optical Detection of a Fiber Span with High Polarization-Mode Dispersion in a Fiber System (U.S. Pat. Ser. No. 6,459,479), Co-Inventors w/ A.E. Willner: S. Lee. (Oct. 1, 2002)
12. Title: Technique for Detecting the Status of WDM Optical Signals (U.S. Pat. Ser. No. 6,480,648), Co-Inventors w/ A.E. Willner: J.R. Dempewolf, W.W. Peck, I. Turner, and R.K. Wade. (Nov. 12, 2002)
13. Title: Polarization-Mode Dispersion Emulator (U.S. Pat. Ser. No. 6,542,650), Co-Inventors w/ A.E. Willner: P. Ebrahimi, E. Ibragimov, R. Khosravani, I.T. Lima, Jr., and C.R. Menyuk. (April 1, 2003)

14. Title: Compensation and Control of Both First-Order and Higher-Order Polarization-Mode Dispersion (U.S. Pat. Ser. No. 6,654,103), Co-Inventors w/ A.E. Willner: S. Lee, L.-S. Yan, and Q. Yu. (Nov. 25, 2003)
15. Title: Compensation for Polarization-Mode Dispersion in Multiple Wavelength-Division Multiplexed Channels Without Separate Compensation for Each Individual Channel (U.S. Pat. Ser. No. 6,603,890), Co-Inventors w/ A.E. Willner: P. Ebrahimi, S.A. Havstad, R. Khosravani, and Y.W. Song. (Aug. 5, 2003)
16. Title: WDM Fiber Amplifiers using Sampled Bragg Gratings (U.S. Pat. Ser. No. 6,621,627), Co-Inventors w/ A.E. Willner: Z. Pan and Y. Xie. (Sept. 16, 2003)
17. Title: Polarization-Division Multiplexing Based on Power Encoding of Two Different Polarization Channels (U.S. Pat. Ser. No. 6,714,742), Co-Inventors w/ A.E. Willner: M.C. Cardakli and M.I. Hayee. (March 30, 2004)
18. Title: Intra-Bit Polarization Diversity Modulation (U.S. Pat. Ser. No. 6,646,774), Co-Inventors w/ A.E. Willner: T. Luo, Z. Pan, A.B. Sahin, Y. Wang, C.-Y. Yu, and Q. Yu. (Nov. 11, 2003)
19. Title: Reconfigurable Optical Recognition of Bit Information in a Digital Data Stream with Different Bit Rates (U.S. Pat. Ser. No. 6,751,416), Co-Inventors w/ A.E. Willner: M.C. Cardakli, D. Gurkan, and S. Lee. (June 15, 2004)
20. Title: Devices and Applications Based on Tunable Waveguiding Bragg Gratings with Nonlinear Group Delays (U.S. Pat. Ser. No. 6,915,040), Co-Inventors w/ A.E. Willner: Y.W. Song and S.M.R. Motaghian Nezam. (July 5, 2005)
21. Title: Optical Dispersion Monitoring Based on Vestigial Sideband Optical Filtering (U.S. Pat. Ser. No. 7,035,538), Co-Inventors w/ A.E. Willner: Z. Pan, L.-S. Yan, and Q. Yu. (April 25, 2006)
22. Title: Monitoring and In-Line Compensation of Polarization Dependent Loss for Lightwave Systems (U.S. Pat. Ser. No. 7,206,517), Co-Inventors w/ A.E. Willner: L.-S. Yan and Q. Yu. (April 17, 2007)
23. Title: Optically Boosted Router (U.S. Pat. Ser. No. 7,369,766), Co-Inventors w/ A.E. Willner: J. Bannister, J. McGeehan, P. Kamath, A. Patel, and J.D. Touch. (May 6, 2008)
24. Title: Code Cycle Modulation: Concept and Implementation (U.S. Pat. Ser. No. 7,616,618), Co-Inventors w/ A.E. Willner: P.V. Kumar, R. Omrani, P. Saghari, and J.D. Touch. (Nov. 10, 2009)
25. Title: Waveguide-Based Dispersion Device (U.S. Pat. Ser. No. 8,483,529), Co-Inventors w/ A.E. Willner: Y. Yue and L. Zhang. (July 9, 2013)
26. Title: Sweep-Free Stimulated Brillouin Scattering-Based Fiber Optical Sensing (U.S. Pat. Ser. No. 8,800,375), Co-Inventors w/ A.E. Willner: M. Tur and A. Voskoboinik. (Aug. 12, 2014)
27. Title: All-optical Tunable Tapped-Delay-Lines using Wavelength Conversion and Chromatic Dispersion Based Delays (U.S. Pat. Ser. No. 8,976,445), Co-Inventors w/ A.E. Willner: S. Khaleghi, M. R. Chitgarha, and O. Yilmaz. (March 10, 2015)
28. Title: On-Chip Two-Octave Supercontinuum Generation Enabled by Advanced Chromatic Dispersion Tailoring in Slotted Waveguides (U.S. Pat. Ser. No. 9,110,219), Co-Inventors w/ A.E. Willner: Y. Yan, Y. Yue, and L. Zhang. (Aug. 18, 2015)
29. Title: Mirrorless-Oscillation in a Waveguide using Non-Degenerate Four-Wave Mixing (U.S. Pat. Ser. No. 9,086,609), Co-Inventors w/ A.E. Willner: Y. Yan and L. Zhang (July 21, 2015)

30. Title: Reconfigurable Optical Transmitter (U.S. Pat. Ser. No. 9,166,721), Co-Inventors w/ A.E. Willner: S. Khaleghi and M. R. Chitgarha. (October 20, 2015)
31. Title: Automatically Locked Homodyne Detection (U.S. Pat. Ser. No. 9,625,320), Co-Inventors w/ A.E. Willner: M. R. Chitgarha, S. Khaleghi, A. Mohajerin-ariaei and M. Ziyadi (Apr. 18, 2017)
32. Title: Systems and Techniques for Orbital Angular Momentum Based Reconfigurable Switching (U.S. Pat. Ser. No. 9,768,909), Co-Inventors w/ A.E. Willner: N. Ahmed, H. Huang, Y. Ren, M. Tur, M. J. Willner, Y. Yan and Y. Yue (Sept. 19, 2017)
33. Title: Adaptive Optics Based Simultaneous Turbulence Compensation of Multiple Orbital Angular Momentum Beams (U.S. Pat. Ser. No. 9,780,872), Co-Inventors w/ A.E. Willner: H. Huang, Y. Ren and G. Xie (Oct. 3, 2017)
34. Title: Phase-Sensitive Regeneration without a Phase-Locked Loop using Brillouin Amplification (U.S. Pat. Ser. No. 10,270,536), Co-Inventors w/ A.E. Willner: A. Almainan, Y. Cao, and M. Ziyadi (Apr. 23, 2019)
35. Title: Systems and Techniques for Communication using Multiple-Input-Multiple-Output Processing of Orbital Angular Momentum Modes (U.S. Pat. Ser. No. 10,291,300), Co-Inventors w/ A.E. Willner: Y. Ren, and L. Li (May 14, 2019)
36. Title: Tunable Optical Channel Slicing and Stitching to Enable Dynamic Bandwidth Allocation (U.S. Pat. Ser. No. 10,277,326), Co-inventor: Y. Cao (April 30, 2019)
37. Title: Systems and Techniques for Communication Using Combined Orbital Angular Momentum and Multiple-Input-Multiple-Output Processing (U.S. Pat. Ser. No. 10,411,811), Co-Inventors w/ A.E. Willner: Y. Ren, L. Li, G. Xie, Y. Cao, Z. Wang, C. Liu, and A. J. Willner (Sept. 10, 2019)
38. Title: Data Encoding and Channel Hopping Using Orbital Angular Momentum Modes (U.S. Pat. Ser. No. 10,750,257), Co-Inventors w/ A.E. Willner: Y. Ren, L. Li, A. J. Willner, and G. Xie (August 18, 2020)
39. Title: System and Method for Extending Path Length of a Wave Signal Using Angle Multiplexing (U.S. Pat. Ser. No. 10,789,009), Co-Inventors w/ A.E. Willner: P. F. McManamon, D. Damaghi, O. Harlev, A. Vedadi-Comte, C. R. Palanzo, and R. J. Howard (Sept. 29, 2020)
40. Title: Data in Motion Storage System and Method (U.S. Pat. Ser. No. 10,812,880), Co-Inventors w/ A.E. Willner: D. Damaghi, O. Harlev, A. Litvin, N. Barak, P. F. McManamon, A. McGuffin (Oct. 20, 2020)
41. Title: Spatial Light Structuring Using a Combination of Multiple Orthogonal Orbital Angular Momentum Beams with Complex Coefficients (U.S. Pat. Ser. No. 10,914,959), Co-Inventors w/ A.E. Willner: L. Li, C. Liu, Y. Ren, G. Xie, and Z. Zhao (Feb. 9, 2021)
42. Title: Apparatus and Method for Storing Wave Signals in a Cavity (U.S. Pat. No. 11,361,794), Co-Inventors w/ A.E. Willner: D. Damaghi, O. Harlev, A. Vedadi-Comte, P. F. McManamon (June 14, 2022)
43. Title: Systems and Methods for Building, Operating and Controlling Multiple Amplifiers, Regenerators and Transceivers Using Shared Common Components (U.S. Pat. No. 11,243,355), Co-Inventors w/ A.E. Willner: D. Damaghi, O. Harlev, P. F. McManamon, A. Vedadi-Comte, D. D. Choudhary (Feb. 8, 2022)
44. Title: Optical Mitigation of Inter-Channel Crosstalk for WDM Channels (U.S. Pat. Ser. No. 11,652,556), Co-Inventors w/ A.E. Willner: F. Alishahi, Y. Cao, A. Fallahpour, A. Mohajerin-Ariaei (May 16, 2023)

45. Title: Multiple Kerr-Frequency-Comb Generation Using Different Lines from a Remote Kerr Comb (U.S. Pat. Ser. No. 11,106,111), Co-Inventors w/ A.E. Willner: P. Liao, A. Almainan, C. Bao (Aug. 31, 2021)
46. Title: Data in Motion Storage System and Method (U.S. Pat. Ser. No. 11,190,858), Co-Inventors w/ A.E. Willner: D. Damaghi, O. Harlev, A. Litvin, N. Barak, P. F. McManamon, A. McGuffin (Nov. 30, 2021)

### **BOOKS:**

1. **Optical Fiber Telecommunications VII**, Alan E. Willner, editor, Elsevier Publishers, Academic Press, San Diego, Oct. 2019, ISBN: 978-0-12-816502-7.  
*\* Top 10 Best Electrical Fiber Optics Books Ranked by FINDTHISBEST.COM \**
2. **Novel Insights into Orbital Angular Momentum Beams: From Fundamentals, Devices to Applications**, Yang Yue, Hao Huang, Yongxiong Ren, Zhongqi Pan, and Alan E. Willner, co-editors, MDPI AG, Basel, Switzerland, Sept. 2019, ISBN: 978-3-03921-223-1.
3. **Optical Fiber Telecommunications VI, Volumes A and B**, Ivan P. Kaminow, Tingye Li, and Alan E. Willner, co-editors, Elsevier Publishers, Academic Press, San Diego, May 2013, ISBN: 978-0-12-396958-3 and 978-0-12-396960-6.
4. **Optical Fiber Telecommunications ebook Collection: Ultimate CD**, Stewart E Miller, Ivan P. Kaminow, Thomas Koch, Tingye Li, and Alan E. Willner, co-editors, Elsevier Publishers, Academic Press, San Diego, Sept. 2008, ISBN: 978-0-12-374643-4 and 978-0-12-374643-6.
5. **Optical Fiber Telecommunications V, Volumes A and B**, Ivan P. Kaminow, Tingye Li, and Alan E. Willner, co-editors, Elsevier Publishers, Academic Press, San Diego, Feb. 2008, ISBN: 978-0-12-374171-4 and 978-0-12-374172-4.
6. **Optical Fiber Communication Systems**, L.G. Kazovsky, S. Benedetto, and A. E. Willner, co-authors, Artech House Publishers, Boston, Oct. 1996, ISBN: 0-89006-756-2.
7. **System Technologies, Trends in Optics and Photonics**, vol. 12, Alan E. Willner and Curtis R. Menyuk, co-editors, Optical Society of America, Washington, D.C., 1997, ISBN: 1-55752-484.
8. **Optical Amplifiers and Their Enabling Technologies, Trends in Optics and Photonics**, vol. 16, and M. N. Zervas, Alan E. Willner, and S. Sasaki, co-editors, Optical Society of America, Washington, D.C., 1998, ISBN: 1-55752-505-6.
9. **Emerging Components and Technologies for All Optical Networks**, Proceedings of SPIE - the International Society for Optical Engineering, vol. 2613, Emil S. Koteles and Alan E. Willner, co-editors, SPIE, Bellingham, WA, 1995, ISBN-13: 978-0819419774.
10. **Optical Fiber Communication**, Proceedings of SPIE - the International Society for Optical Engineering, Winston I. Way, Franklin K. Tong, and Alan E. Willner, co-editors, SPIE, Bellingham, WA, 1998, ISBN-13: 978-0819428745.

### **INVITED BOOK CHAPTERS:**

1. Alan E. Willner, Runzhou Zhang, Kai Pang, Haoqian Song, Cong Liu, Hao Song, Xinzhou Su, Huibin Zhou, Nanzhou Hu, Zhe Zhao, Guodong Xie, Yongxiong Ren, Hao Huang, and Moshe Tur, "High-Capacity

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35. Alan E. Willner, “Mitigation of Intra-Modal-Group Power Coupling of Few-Mode Fiber,” **Invited Paper, IEEE Photonics Conference (IPC) 2021**, paper **TuF4.3**, Oct. 2021 (IEEE, Piscataway, NJ, 2021).
36. Alan E. Willner, “Optical Communications: Innovations and Applications Abound,” **Plenary Paper, Applied Optics and Photonics China**, Beijing, China, July 2021.
37. Alan E. Willner, “Optical Communications: Innovations and Applications Abound,” **Invited Presentation, Distinguished Lecture, Institute for Broadband Research and Innovation (IBRI), Soochow University**, Jiangsu, China, July 2021.

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38. Alan E. Willner, “Optical Communications Innovations for Free-Space and Optical-Signal-Processing Applications,” **Invited Paper, IPEC Workshop**, June 2021.
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97. Alan E. Willner, "Structured Light Using OAM and Wavelength Domains for Terabit/sec Communications," **Invited Presentation, APS/IEEE/OSA Conference on Lasers and Electro-Optics (CLEO)**, San Jose, CA, May 2017 (Optical Society of America, Wash., D.C., 2017).
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109. Alan E. Willner, "High-Capacity Communications using Multiplexing of Multiple Orbital-Angular-Momentum Beams," **Plenary Presentation, Physics of Quantum Electronics (PQE) Meeting**, Snowbird, UT, Jan. 2017.
110. Alan E. Willner, "Innovations Abound in Functional Optical Communications," **Plenary Presentation, IEEE/OSA/SPIE Asia Communications and Photonics Conference (ACP)**, Wuhan, China, Nov. 2016 (Optical Society of America, Washington, D.C., 2016).
111. Alan E. Willner, "Perspectives on Using OAM Multiplexing and Encoding for Communications," **Invited Paper, IEEE/OSA/SPIE Asia Communications and Photonics Conference Workshop on Twisting Light with Orbital Angular Momentum (OAM): Advances and Opportunities**, Wuhan, China, Nov. 2016 (Optical Society of America, Washington, D.C., 2016).
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120. Alan E. Willner, "Physics Behind Optical Fiber Communications: Technologies that Drive the Internet Capacity Growth," **Invited Paper, American Physical Society (APS) March Meeting 2016**, Baltimore, March 2016.
121. Alan E. Willner, "Innovation in Photonics R&D," **Invited Presentation, Lloyd Greif Center for Entrepreneurial Studies, Marshall School of Business, USC**, Jan. 28, 2015 and Jan. 26, 2016.
122. Yongxiong Ren, Guodong Xie, Asher J. Willner, Nisar Ahmed, Long Li, Zhe Wang, and Alan E. Willner, "Challenges and Opportunities in using Orbital Angular Momentum for Communication Links," **Invited Presentation, Asia Communications and Photonics Conference (ACP) Workshop on Recent Advances in Space-Division Multiplexing (SDM)**, Hong Kong, China, Nov. 2015 (Optical Society of America, Wash., D.C., 2015).
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126. Alan E. Willner, "Optics and Photonics; Essential Technologies for our World", **Plenary Presentation, New Mexico International Year of Light Event**, Albuquerque, NM, Sept. 2015.
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227. Alan E. Willner, "Advanced Optical Signal Processing Functions using Integrated Photonics," **Invited Paper, Center for High Technology Materials (CHTM) Silver Event**, Univ. of New Mexico, Aug. 2009.
228. Alan E. Willner, "Acute Need for Optical Chip Fab & Packaging: An Academic User's Perspective," **Invited Presentation, Workshop on Photonics Engineering Prototyping Resource (PEPR)** (sponsored by Air Force Research Laboratory), Dayton, OH, July 2009.
229. A.E. Willner, "Achieving Tunable Delays using Wavelength Conversion," **Invited Paper, Society of Photo-Instrumentation Engineers (SPIE) Photonics West, Conference on Advances in Slow and Fast Light II (OPTO OE116)**, paper 7226-11, Jan. 2009, San Jose, CA (SPIE, Bellingham, Wash., 2009).
230. Alan E. Willner, "Optical Communications: Innovations (and their Needs) Abound," **Invited Presentation, Colloquium Lecture Series**, College of Optical Sciences, Univ. of Arizona, March 5, 2009.
231. Alan Willner, "Negotiating an Academic Job Offer," **Invited Seminar, USC Center for Excellence in Teaching (CET) Seminar**, Oct. 2009.
232. A.E. Willner, B. Zhang, L. Zhang, L.-S. Yan, and I. Fazal, "Optical Signal Processing using Tunable Delay Elements Based on Slow Light," **Invited Paper, IEEE Journal of Selected Topics in Quantum Electronics**, Special Issue on Nonlinear Optical Signal Processing, vol. 14, pp. 691-705, 2008.
233. Alan E. Willner, "Optical Communications: Innovations (and their Needs) Abound," **Invited Presentation, 100<sup>th</sup> Anniversary of Corning's R&D, Corning's Stookey Award Ceremony**, Corning R&D Laboratories, Corning, NY, Oct. 2008.
234. A.E. Willner, "Stable and Reconfigurable High-Capacity Optical Networks," **Plenary Paper, IEEE Photonics Global Singapore (IPGC 2008)**, 7<sup>th</sup> Int'l Conference on Optical Communications & Networks (ICOON), Singapore, Dec. 2008.
235. Alan E. Willner, "Towards Stable and Reconfigurable High-Capacity Optical Networks," **Plenary Paper, International Conference on Optics and Photonics in Taiwan 2008**, paper Fri-AP-01, Taipei, Taiwan, Dec. 2008.
236. A.E. Willner, "Targeted Optical Signal Processing for High-Performance Optical Networking," **Plenary Paper, CS/IEICE/IEEE Conference on Photonics in Switching**, Saporro, Japan, Aug. 2008.

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237. A.E. Willner, "Future Broader-Bandwidth Optical Communication Systems," **Plenary Paper, IEEE Lasers and Electro-Optics Society Summer Topical Meeting on Mitigating Channel Degrading Effects**, Proceedings, Acapulco, Mexico, July 21-23, 2008 (IEEE, Piscataway, NJ, 2008).
238. Alan Willner, "Towards High-Performance and Reconfigurable Optical Communication Networks," **Invited Seminar, Applied Physics Seminar Series, California Institute of Technology** (Caltech), Nov. 2008.
239. Alan E. Willner, "Optical Communications: Innovations (and their Needs) Abound," **Invited Presentation, Distinguished Lecture, The Annual Boris Stoicheff Lecture**, Jointly by the Institute of Optical Sciences (Univ. of Toronto) and the Royal Canadian Institute, Dec. 2008.
240. Alan E. Willner, "Towards High-Performance and Reconfigurable Optical Communication Networks," **Invited Seminar, IEEE ComSoc and LEOS Baltimore Chapter Seminar Series**, Oct. 2008.
241. Alan E. Willner, "Optical Performance Monitoring for Reconfigurable Optical Networks," **International Nano-Optoelectronic Workshop (iNOW)**, Japan, Aug. 2008.
242. Lin Zhang, Muping Song, Raymond G. Beausoleil and Alan E. Willner, "Embedded Ring Resonators," **Invited Paper** for Winner of LEOS Figure Contest, IEEE LEOS Newsletter, vol. 22, no. 6, pp. 21-22, 2008.
243. A.E. Willner, "High-Performance Gbit/s Data Transmission Through Slow Light Elements," **Invited Paper, Optical Society of America (OSA) Topical Meeting on Slow and Fast Light**, paper SMC1, Boston, July 2008 (OSA, D.C., 2008).
244. Alan E. Willner and Lin Zhang, "Physical Layer Challenges of On-Chip Optical Interconnects," **Invited Presentation, HP Photonic Interconnect Forum**, Hewlett-Packard Laboratories, Palo Alto, CA, May 2008.
245. A.E. Willner, "Value of Societies to Your Career: Plant the Flag to be a Leader," **Invited Presentation, OSA Student Activities Workshop, Conference on Lasers and Electro-Optics (CLEO)**, San Jose, CA, May 2008 (Optical Society of America, Wash., D.C., 2008).
246. A.E. Willner and B. Zhang, "Tunable Delay Lines using Slow Light for Gbit/s Data Signals," **Invited Paper, Society of Photo-Instrumentation Engineers (SPIE) Photonics West, Conference on Advances in Slow and Fast Light (OE21)**, paper 6904-09, Jan. 2008, San Jose, CA (SPIE, Bellingham, Wash., 2008).
247. A.E. Willner, "All-Optical Signal Processing in Next-Generation Communication Systems" **Invited Presentation, Workshop OMD on All-Optical Signal Processing and Conditioning, Conference on Optical Fiber Communications (OFC)**, San Diego, CA, Feb. 2008.
248. A.E. Willner, "Specialty Fibers to Realize Signal Processing Functions," **Invited Presentation, Workshop OSuA on "Is Optical Transmission Fiber a Commodity or is Further Innovation Required?," Conference on Optical Fiber Communications (OFC)**, San Diego, CA, Feb. 2008.
249. A.E. Willner, "Systems Requirements for Signal Processing using Parametric Processes," **Invited Presentation, Workshop OMD on All-Optical Signal Processing and Conditioning, Conference on Optical Fiber Communications (OFC)**, San Diego, CA, Feb. 2008.
250. Alan E. Willner, "Optical Networking Perspectives vs. Optical Technologies Reality," **Keynote Presentation, ONDM Conference COST 291 Workshop**, International Federation of Information Processing (IFIP), Athens, Greece, May 2007.
251. A.E. Willner, "Opportunities & Challenges in Optical Networking," **Plenary Presentation, 9<sup>th</sup> International Conference on Transparent Optical Networks (ICTON)**, Rome, Italy, July 2007.

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- 252. A.E. Willner, "Robust and Reconfigurable Optical Communication Systems," **Plenary Presentation**, Workshop on Optical Communications, **Advanced Communications Center**, Tel Aviv University, Dec. 2007.
- 253. A.E. Willner, "Stable and Reconfigurable Optical Networks," **Invited Paper, IEEE Lasers and Electro-Optics Society Annual Meeting 2007**, paper WFF1, Orlando, Oct. (IEEE, Piscataway, NJ, 2007).
- 254. Yannick Keith Lize, Xiaoxia Wu, Louis Christen, Mathieu Faucher, and Alan E. Willner, "Free Spectral Range and Optical Filtering Optimization in NRZ-, RZ- and CSRZ-DPSK Demodulation," **Invited Paper, IEEE Lasers and Electro-Optics Society Annual Meeting 2007**, paper MP1, Orlando, Oct. (IEEE, Piscataway, NJ, 2007).
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- 255. Alan E. Willner, Poorya Saghari, and Vahid R. Arbab, "Advanced Techniques to Increase the Number of Users and Bit Rate in OCDMA Networks," **Invited Paper, IEEE Journal of Selected Topics in Quantum Electronics**, Special Issue on Optical Codes in Optical Communications and Networks, vol. **13**, pp. 1403-1414, 2007.
- 256. A.E. Willner, "The Resume Process: Not it, but about it," **Invited Presentation, USC Academic Careers Week**, Oct. 2007.
- 257. A.E. Willner, "Managing Multiple Roles for Faculty: Just say no, sometimes," **Invited Presentation, USC's Academic Leadership and Development Workshop on Managing Multiple Roles as Faculty**, November 2007.
- 258. Alan E. Willner, "Physical-Layer Challenges in Stable, High-Capacity Optical Communication Networks," **Invited Presentation**, Dept. of Applied Physics Seminar Series, Hebrew University, June 6, 2007.
- 259. A.E. Willner, "Tunable Optical Delay Lines for Switching and Processing," **Invited Paper, IEEE Photonics in Switching Topical Meeting**, San Francisco, Aug. 2007 (IEEE, Piscataway, NJ, 2007).
- 260. Alan E. Willner, "Physical-Layer Challenges in Stable, High-Capacity Optical Communication Networks," **Invited Colloquium, Institute of Optics**, University of Rochester, Rochester, NY, Feb. 2007.
- 261. Alan E. Willner, "Monitoring and Channel Measurements to Enable Stable, High-Capacity Optical Networks," **Invited Seminar**, NIST, Boulder, Colorado, Feb. 2007.
- 262. A.E. Willner, "Leverage the Show Floor to Your Advantage," **Invited Presentation**, Student Activities Workshop, **Conference on Lasers and Electro-Optics (CLEO)**, Baltimore, MD, May 2007 (Optical Society of America, Wash., D.C., 2007).
- 263. Alan E. Willner, "Physical-Layer Challenges in Stable, High-Capacity Optical Communication Networks," **Keynote Paper, Asia Optical Communications and Optoelectronics Exhibition (AOE)**, Shanghai, China, Oct. 2006.
- 264. A.E. Willner, "Optical Performance Monitoring for Robust Optical Networks," **Invited Seminar**, Dept. of Electrical Engineering, Univ. of Melbourne, Melbourne, Australia, Oct. 2006.
- 265. Alan E. Willner, "Photonic Integration for Smart and Robust Communication Systems," **Plenary Presentation**, MIT Center for Integrated Photonic Systems (CIPS) Annual Meeting, May 5, 2006.
- 266. Zhaoming Zhu, Andrew M.C. Dawes, Daniel Gauthier, Michael D. Stenner, Mark A. Neifeld, Ting Luo, Changyuan Yu, Lin Zhang, and Alan E. Willner, "Recent Advances in Stimulated Brillouin Scattering Slow

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267. Alan E. Willner, "Photonic Integration for Smart and Robust Communication Systems," **Invited Presentation**, UC Berkeley Summer School, **Nano-Opto Workshop** (NOW, CONSRT), Aug. 14, 2006.
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269. L.-S. Yan, X. Steve Yao, M.C. Hauer, and A.E. Willner, "Practical Solutions to Polarization-Mode-Dispersion Emulation and Compensation," **Invited Paper, IEEE/OSA Journal of Lightwave Technology**, Special Issue on Polarization Effects, vol. **24**, no. 11, pp. 3992-4005, 2006.
270. Alan E. Willner, "The Optical Network of the Future: Can Optical Performance Monitoring Enable Automated, Intelligent and Robust Systems?," **Invited Paper, Optics and Photonics News**, pp. 30-35, March, 2006.
271. Alan E. Willner, "Physical-Layer Challenges in Stable, High-Capacity Optical Communication Networks," **Invited Presentation**, Annual Research Review of the NSERC Research Center on Agile All-Photonics Networks (AAPN), Ottawa, Canada, June 15, 2006.
272. Alan E. Willner, "Self-Managing Intelligent Optical Networks for Smarter, Tougher, and Cheaper Systems," **Invited Paper, Society of Photo-Instrumentation Engineers (SPIE) Newsroom**, Manuscript 743 (10.1117/2.1200603.0128), April 2006 (SPIE, Bellingham, Wash., 2006).
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274. A.E. Willner, L. Zhang, T. Luo, C. Yu, W. Zhang, and Y. Wang, "Data Bit Distortion Induced by Slow Light in Optical Communication Systems," **Invited Paper, Society of Photo-Instrumentation Engineers (SPIE) Photonics West, Symposium on Integrated Optoelectronic Devices**, paper 6130-29, pp. 175-192, Jan. 2006, San Jose, CA (SPIE, Bellingham, Wash., 2006).
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278. A.E. Willner and J.E. McGeehan, "Physical Layer Routing Issues in Free-Space Optical Communication Networks," **Invited Paper, IEEE Lasers and Electro-Optics Society Summer Topical Meeting on Free-Space Communication Techniques for Optical Networks**, Proceedings, paper MA3.3, San Diego, CA, July 25-27 (IEEE, Piscataway, NJ, 2005).

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279. Martin M. Fejer and Alan E. Willner, "Digital Signal Processing using Periodically-Poled Lithium-Niobate Waveguides," **Invited Paper, IEEE Lasers and Electro-Optics Society Summer Topical Meeting on Optical Signal Processing**, Proceedings, paper TuC1.1, San Diego, CA, July 25-27 (IEEE, Piscataway, NJ, 2005).
280. Alan E. Willner, "Technical Innovations Needed to Build Optical Networks," **Invited Presentation, NSF-Sponsored Workshop** on "The Future of Optical Communications: Understanding the Choices," Santa Barbara, Feb. 2005.
281. A.E. Willner, "Transmission Challenges in 40-Gbit/s Networks," **Invited Paper, Optoelectronics Industry Development Association (OIDA) PTAP 40 Gbit/s Workshop**, Chicago, May 2005.
282. A.E. Willner, "FBG-Based Optical Correlators for Networking," **Invited Paper, Bragg Gratings, Poling & Photosensitivity/ 30th Australian Conference on Optical Fibre Technology (ACOFT/BGPP)**, Sydney, Australia, July 2005.
283. A.E. Willner, S.M.R. Motaghian Nezam, L.-S. Yan, Z. Pan, and M.C. Hauer, "Monitoring and Control of Polarization-Related Impairments in Optical Fiber Systems," **Invited Paper, IEEE/OSA Journal of Lightwave Technology**, Special Issue on the Conference on Optical Fiber Communications, vol. 22, pp. 106-125, 2004.
284. Alan E. Willner, "Emerging Issues in Optical Fiber Communication Systems," **Plenary Paper**, Joint Plenary Session of the 2004 **Australian Conference on Fibre Technology (ACOFT)** and the **Australian Optical Society Annual Meeting**, Canberra, Australia, July 7, 2004.
285. A.E. Willner, S. Kumar, B. Zhang, and E. Pakbaznia, "Physical Impairments and Network Limitations When Interconnecting Multiple DOD-N Routers," **Invited Paper, IEEE Lasers and Electro-Optics Society Annual Meeting 2004**, Special Symposium on DARPA's DOD-N Program, paper MI5, Puerto Rico, Nov. (IEEE, Piscataway, NJ, 2004).
286. A.E. Willner and M.C. Hauer, "PMD Emulation," **Invited Paper, Journal of Optical and Fiber Communications Reports, Springer-Verlag**, vol. 1, no. 3, pp. 181-200, 2004.
287. A.E. Willner, "Communications Overview: A Converged, Robust Future in Communications," **Invited Paper, DARPA MTO Symposium on Photonics**, Session WE2, San Francisco, CA, Dec. 2004.
288. A.E. Willner, "Monitoring, Security & Routing in High-Capacity Optical Networks," **Invited Paper, Cisco Systems Optical Daze Symposium**, Dec. 2004
289. Z. Pan, A.E. Willner, C. Yu, and Y. Wang, "Applications of Highly Nonlinear Fiber in WDM Communications Systems," **Invited Paper, OSA/SPIE Optics in the Southeast**, paper D2, November 4-5, Charlotte, North Carolina, 2004.
290. A.E. Willner, "Monitoring and Emulation of Fiber-Based Dispersive Effects," **Invited Paper, IEEE Lightwave Technologies in Instrumentation & Measurement Conference**, paper LTIMC-28, Palisades, NY, Oct. 2004 (IEEE, Piscataway, NJ, 2004).
291. A.E. Willner, "Systems Applications for Slow Light Technologies," **Invited Paper, CRI (Charlotte Research Institute) Conference on Slow Light**, Univ. of North Carolina, Charlotte, NC, July 2004.
292. A.E. Willner, "High-Capacity Optical Systems and Networks," **Invited Presentation, Nerd Lunch Seminar Series**, Cisco Systems, San Jose, Jun 2004.

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295. S. Lee and A.E. Willner, "Optical Communication Systems: Basic Concepts," **Invited Paper, Encyclopedia of Modern Optics**, pp. 376-386, edited by Robert D. Guenther, Duncan G. Steel and Leopold Bayvel, Elsevier, Oxford, ISBN 0-12-227600-0, 2004.
296. A.E. Willner, "PMD in Optical Communication Systems," **Plenary Paper, IEEE Lasers and Electro-Optics Society Summer Topical Meeting on Polarization Mode Dispersion**, Proceedings, Vancouver, Canada, July 14-16 (IEEE, Piscataway, NJ, 2003).
297. Alan Willner and L.-S. Yan, "Performance Degradations and Monitoring in Optical Networks," **Invited Paper, Asia-Pacific Optical and Wireless Communications Conference**, paper 5282-39, Wuhan, China, Nov. 2003 (SPIE, Bellingham, WA, 2003).
298. Alan E. Willner, "Physical Layer Impairments and Solutions," **Invited Paper, Globecom, Workshop on Optical Burst Switching**, San Francisco, Dec. 2003 (IEEE, Piscataway, NJ, 2003).
299. Alan E. Willner, "Is Circuit Switching So Much Easier Than Packet Switching?," **Invited Paper, Workshop on Optical Networking: Circuit or Packet Switching? – Where, When and How?**, Workshop PS.We.Workshop1, **Photonics in Switching**, Versailles, France, Oct. 2003 (Optical Society of America, Wash., D.C., 2003).
300. Alan E. Willner, "Do What Optics Does Best," **Invited Paper, Workshop on Signal Processing Strategies in Optical Networks and the Impact of Advanced Optical/Electrical Components**, Workshop PS.We.Workshop4, **Photonics in Switching**, Versailles, France, Oct. 2003 (Optical Society of America, Wash., D.C., 2003).
301. Alan E. Willner, Deniz Gurkan, Asaf B. Sahin, John E. McGeehan, and Michelle C. Hauer, "All-Optical Address Recognition for Optically-Assisted Routing in Next-Generation Optical Networks," **Invited Paper, IEEE COMSOC Communications Magazine**, vol. 41, no. 5, **Optical Communications Supplement**, vol. 1, no. 2, pp. S38-S44, May 2003.
302. Alan E. Willner and Lianshan Yan, "PMD Emulation: Requirements and Results," **Invited Paper, Workshop on PMD: Causes, Effects, and Cures**, Workshop W3, **European Conference on Optical Communications (ECOC)**, Rimini, Italy, Sept. 2003.
303. Alan E. Willner, "Predictions for Optical Communications," **Invited Paper, Part D: Future Prospects in Optoelectronic Systems, Handbook of Photonics**, Alan Rogers, editor, Institute of Physics Publishing, Bristol, UK, Dec. 2003.
304. Alan E. Willner, Yong-Won Song, John McGeehan, Zhongqi Pan, and Bogdan Hoanca, "Dispersion Management," **Invited Paper, Encyclopedia of Modern Optics**, manuscript 675, Elsevier Publishers, 2004.
305. A.E. Willner, "Overview of System Applications of EIT Technologies," **Invited Paper, Slow Light**, DARPA-Sponsored Workshop, Orlando, Florida, Dec. 2003.
306. A.E. Willner, "Combating Channel-Degrading Effects in Multiple-Wavelength Optical Systems," **Invited Presentation, Nerd Lunch Seminar Series**, Cisco Systems, San Jose, July 2003.

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307. A.E. Willner, "Troubles Ahead: Which Impairments Will Drive Higher Levels of OPM?" **Invited Presentation**, Workshop on the Need for Optical Performance Monitoring, **Conference on Optical Fiber Communications (OFC)**, Session MC, Atlanta, Georgia, March 2003.
308. A.E. Willner, "Tunable Dispersion Compensation: The Overlap Between What Research Can Provide and What Industry Needs," **Invited Presentation**, Workshop on Tunable Dispersion Compensation, **Conference on Optical Fiber Communications (OFC)**, Session SE, Atlanta, Georgia, March 2003.
309. A.E. Willner, "Trends and Limitations of Optical Network Technologies," **Plenary Paper, 7th Opto-Electronics and Communications Conference (OECC)**, Pacifico Yokohama, Kanagawa, Japan, July 9, 2002.
310. A.E. Willner, "Tunability in Dispersion Compensation," **Invited Paper, IEEE Lasers and Electro-Optics Society Annual Meeting**, Proceedings, Glasgow, Scotland, Nov. 2002 (IEEE/LEOS, Piscataway, NJ, 2002).
311. A.E. Willner, "All-Optical Packet-Header-Recognition Techniques," **Invited Paper, IEEE Lasers and Electro-Optics Society Annual Meeting**, Proceedings, Glasgow, Scotland, Nov. 2002 (IEEE/LEOS, Piscataway, NJ, 2002).
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326. A.E. Willner, "Chromatic Dispersion Compensators: The Search for Tunability," **Invited Paper, Next Generation Networks Conference**, Boston, MA, Nov. 2001.
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328. A.E. Willner, "Reconfigurable Multiple-Wavelength Optical Systems: Things Change," **Invited Paper, Optical Materials for Future Devices and Systems**, DARPA-Sponsored Workshop, Clearwater Beach, Florida, Sept. 2001.
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