

Robert A. Norwood
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College of Optical Sciences
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Education

- B.S. Physics, Massachusetts Institute of Technology, 1983
- B.S. Mathematics, Massachusetts Institute of Technology, 1983
- Ph. D. Physics, University of Pennsylvania, 1988

Employment

- University of Arizona:
College of Optical Sciences, Professor, 2009 - present
College of Optical Sciences, Research Professor, 2004-2009
- Photon-X:
Vice President/Chief Technology Officer, 1999-2004
- Allied Signal (Honeywell):
Senior Technical Leader, 1998-1999
Senior Project Leader, 1996-1998
Senior Research Scientist, 1995 – 1996
- Hoechst Celanese:
Staff Physicist/Project Leader, 1993-1995
Senior Research Physicist, 1992-1993
Senior Research Physicist, 1990 - 1991
Research Physicist, 1988-1990
- Hoechst Japan:
Supervisor, Advanced Technology Laboratory, 1992
- Haverford College:
Visiting Instructor, 1988
- University of Pennsylvania:
Research and Teaching Fellow, 1983-1988

Professional Affiliations

- OSA – Optical Society of America, **Fellow**
- SPIE – The International Society for Optical Engineering, **Fellow**
- APS – American Physical Society, Member

University of Arizona: Long—Term Research Goals

- Further the understanding and performance of organic and polymeric materials for photonics and electronics applications

University of Arizona: Funded Research Projects

- Electro-optic polymers and devices
 - National Science Foundation, Engineering Research Center for Integrated Access Networks, "Low Cost EO Modulators for High Bit Rate Data Centers," PI (2008 – 2017)
 - AFOSR/TIPD, LLC "Scale-up of EO Polymers and their Utilization in Novel Nano-imprinted Sub-wavelength Waveguide-based Modulators and Arrays," PI (2014-2016)
- Photonics Manufacturing

- AIM Photonics, TAP program “High Throughput Manufacturing for PIC Polymer Waveguide Connection,” co-PI (2016-2017)
- Optical materials
 - National Science Foundation, “Chalcogenide-based Hybrid Polymers with High Refractive Index for IR Thermal Imaging,” co-PI (2016-2019)
- Ultrafast optical switching and limiting
 - Office of Naval Research MURI, “Near-Field Nanophotonics for Energy Efficient Computing and Communication,” PI (2013 – 2018)
- Solar energy
 - ARPA-E, “A CPV/CSP Hybrid Solar Energy Conversion System with Full Use of the Solar Spectrum,” PI (2014 – 2017)
 - ARPA-E, “A High-efficiency Flat Plate PV with Integrated Micro-CPV Atop a 1-Sun Panel,” PI (2016 – 2019)

University of Arizona: Additional Research Interests

- Sol-gels
- Polymer optical interconnects
- Polymer/nanoparticle composites
- Solar energy systems
- Fiber lasers
- Liquid photonics
- Biosensors
- Plasmonics
- Tunable optical filters
- Multiphoton microscopy of 2D materials
- Nonlinear optical materials
- Engineered dielectric materials
- Materials for advanced photolithography
- Optical physics and nonlinear optics of biomolecules
- Precise measurement of thin film linear optical properties

University of Arizona: Teaching

- Opti 439A/539A – From Photonics Innovation to the Marketplace (undergraduate/graduate)
- Opti553 – Nonlinear Photonics (graduate)

Photon-X: Key Industrial Research Projects

- Achieved lowest loss single mode polymer optical waveguide at telecommunications wavelengths
- Compact, low power consumption erbium doped fiber amplifiers for avionics applications
- Low-loss athermal arrayed waveguide grating router in polymers
- Organic optical amplifier materials with the highest luminescence efficiencies ever recorded

AlliedSignal: Key Industrial Research Projects

- Polymer waveguide Bragg gratings with exceptional spectral performance and tunability
- Invented reconfigurable optical add-drop multiplexers and tunable filters
- MEMS single-mode fiber switch with ultra-low loss
- Fluorinated UV-patternable optical waveguide with low loss and superior stability

Hoechst Celanese: Key Industrial Research Projects

- Quasiphasematching in poled polymer waveguides for frequency doubling and difference frequency generation
- Picosecond degenerate four wave mixing measurements of the optical nonlinearities of organic thin films
- Photothermal deflection spectroscopy for the measurement of very small absorptions in organic films
- Organic crystal for frequency doubling from 840nm to 420nm with exceptional transparency (Hoechst Japan)
- Non-invasive high speed electric field measurements using electro-optic polymer patch sensors (Hoechst Japan – collaboration with NTT)
- Sol-gel barrier coatings for polymer films providing wet coatings with ultra-high barrier

- Novel top and bottom anti-reflection coatings for photolithography

Scientific Community Service

- *Optica*, Associate Editor 2015 - present
- Member: Program Committee CLEO 2017
- *IEEE Photonics Technology Letters*, Associate Editor 2010 - 2013
- *Optical Materials Express*, Associate Editor 2011 - 2013
- *Applied Physics Letters*, Reviewer
- *Chemistry of Materials*, Reviewer
- *Electronics Letters*, Reviewer
- *IEEE Journal of Quantum Electronics*, Reviewer
- *IEEE Photonics Technology Letters*, Reviewer
- *Journal of Applied Physics*, Reviewer
- *Journal of the Optical Society of America B*, Reviewer
- *Journal of Physical Chemistry*, Reviewer
- *Optics Letters*, Reviewer
- Member: Committee, OSA *Optical Materials Studies Technical Group* 2015 -
- Member: Program Committee, *Photonics in Switching*, 2014-2015
- Member: Program Committee, SPIE *Organic Photonic Materials and Devices* 2010-2016
- Member: Program Committee, SPIE *Integrated Optics: Devices, Materials and Technologies*
- OSA Fellows Committee Chair 2010
- OSA Fellows Committee Member 2009
- Conference Chair: SPIE *Linear and Nonlinear Optical Properties of Organic Materials VI* 2006
- Chair: Subcommittee D, *Optical Switching and Wavelength Routing Devices*, OFC 2006
- NSF Review Panelist: National Science Foundation 2005
- Conference Chair: SPIE *Linear and Nonlinear Optical Properties of Organic Materials V* 2005
- Member: Program Committee, OFC 2005
- Conference Chair: SPIE *Linear and Nonlinear Optical Properties of Organic Materials IV* 2004
- Member: Program Committee, OFC 2004
- Member: Program Committee, CLEO 2004
- Member: Program Committee, CLEO 2003
- Member: Program Committee, OFC 2003
- Conference Chair: SPIE *Linear Optical Properties of Fibers and Waveguides* 2003
- Member: Program Committee, *Organic Thin Films '02 and Polymer Photonic Devices* 2003
- Member: Program Committee, CLEO 2002
- Conference Chair: SPIE *Linear Optical Properties of Fibers and Waveguides* 2002
- Member: Program Committee, *Organic Thin Films '01 and Polymer Photonic Devices* 2002
- Conference Chair: SPIE *Linear Optical Properties of Fibers and Waveguides* 2001
- Member: Program Committee, *Organic Thin Films '00 and Polymer Photonic Devices* 2001
- Conference Chair: SPIE *Linear Optical Properties of Fibers and Waveguides* 2000
- Program Co-Chair: *Organic Thin Films* 2000
- Member: Program Committee, *Organic Thin Films '99 and Polymer Photonic Devices* 2000
- Conference Chair: SPIE *Linear Optical Properties of Fibers and Waveguides* 1999
- Member: Program Committee, *Organic Thin Films '98 and Polymer Photonic Devices* 1999
- Program Co-Chair: *Organic Thin Films* 1999
- Member: Program Committee, *Organic Thin Films '97 and Polymer Photonic Devices* 1998

Book Chapters

- C. T. DeRose, C. Greenlee, A. Yeniay, and R. A. Norwood, "Organic waveguides, ultra-low loss demultiplexers, and electro-optic polymer devices," in *Handbook of Optical Materials for Optical and Optoelectronic Devices: Properties and Applications* edited by O. Ostroverkhova (Woodhead Publishing Series on Electronic and Optical Materials, 2013).
- J. Thomas, R. A. Norwood, and N. Peyghambarian, "Photorefractive polymers for dynamic holography," in *New Directions in Holography and Speckle* ed. by H. J. Caulfield and C. S. Vikram (American Scientific Publishers, 2008).

- R. A. Norwood, "Four-wave mixing tables and measurement techniques," for *Handbook of Electrooptical and Optical Materials: Linear and Nonlinear Properties* ed. by M. G. Kuzyk and C. W. Dirk (Marcel Dekker, 1998).
- G. Khanarian, M. Mortazavi, and R. A. Norwood, "Frequency doubling and parametric interactions in organic thin films," in *Organic Thin Films for Waveguiding Nonlinear Optics*, ed. by J. Swalen (Gordon and Breach, 1996).
- R. A. Norwood, T. K. Findakly, H. A. Goldberg, G. Khanarian, J. B. Stamatoff, and H. N. Yoon, "Optical polymers and multifunctional materials," in *Polymers for Lightwave and Integrated Optics: Technology and Applications* ed. by L. A. Hornak (Marcel Dekker, 1992).
- H. N. Yoon, R. A. Norwood, and H.-T. Man, "Nonlinear optics and materials," in *Ullman's Encyclopedia*, 5th edition, Volume A17, p. 541 (VCH Verlagsgesellschaft, Weinheim, 1991).

US Patents

- D.-C. Pyun, J. J. Griebel, W. J. Chung, R. Glass, R. A. Norwood, R. Himmelhuber, and A. G. Simmonds, "High sulfur content copolymers and composite materials and electrochemical cells and optical elements using them," 9,306,218.
- P. Gangopadhyay, A. Lopez-Santiago, and R. A. Norwood, "Magnetic-core polymer-shell nanocomposites with tunable magneto-optical and/or optical properties," 9,011,710
- R. A. Norwood, D. A. Loy, R. Himmelhuber, and J. Kato, "Method for producing metal oxide organic compound, composite," 8,940,807.
- R. A. Norwood, P. Gangopadhyay, A. A. Mile, J. Kato, S. Virji-Khalfan, and M. Miyawaki, "Method of purifying nanodiamond powder and purified nanodiamond powder," 8,940,267.
- R. S. Witte, L. G. Montilla, R. Olafsson, C. M. Ingram, Z. Whang, R. A. Norwood, and C. Greenlee, "Ultrasonic/photoacoustic imaging devices and methods," 8,879,352.
- J. Thomas, N. N. Peyghambarian, R. A. Norwood, P. Gangopadhyay, and A. A. Khosroabadi, "Nanostructured electrodes and active polymer layers," 8,859,423.
- X. Zhu, N. N. Peyghambarian, and R. A. Norwood, "Mid-infrared supercontinuum fiber laser," 8,804,777.
- R. A. Norwood and T. Skotheim "Nanoamorphous carbon-based photonic crystal infrared emitters," 8,076,617.
- N. Peyghambarian, R. A. Norwood, P. A. Blanche, and S. Tay, "System and method using a voltage kick-off to record a hologram on a photorefractive polymer for 3D holographic display and other applications," 7,973,989.
- C. T. DeRose, R. Himmelhuber, R. A. Norwood, and N. Peyghambarian, "Hybrid strip-loaded electro-optic polymer/sol-gel modulator," 7,912,327.
- C. T. DeRose, R. A. Norwood, and N. Peyghambarian, "Technique to enhance the electro-optic coefficient of polymers by using a sol-gel cladding layer to increase poling efficiency," 7,391,938
- R. Gao, D. S. Bitting, R. M. Mininni, R. A. Norwood, K. Takayama, and A. F. Garito, "Polymer optical waveguides on polymer substrates," 6,917,749
- B. Xu, L. Eldada, R. A. Norwood, and R. M. Blomquist, "Optical devices made from radiation curable fluorinated compositions," 6,800,424
- R. M. Blomquist and R. A. Norwood, "Tunable, polymeric core fiber Bragg gratings," 6,768,839
- R. A. Norwood, L. Eldada, S. Yin, C. Glass, and R. M. Blomquist, "Planar polymeric waveguide devices with temperature dependence control features," 6,684,019
- K. Takayama, D. Bitting, and R. A. Norwood, "Planar optical waveguide with core barrier," 6,603,917
- L. Eldada and R. A. Norwood, "Tunable optical add/drop multiplexer," 6,560,386
- B. Xu, L. Eldada, R. A. Norwood, and R. Blomquist, "Optical devices made from radiation curable fluorinated compositions," 6,555,288
- R. A. Norwood, A. F. Garito, and A. Panackal, "Codopant polymers for optical amplification," 6,538,805
- R. A. Norwood and C. C. Teng, "Thin film optical waveguides," 6,473,551
- L. Eldada and R. A. Norwood, "Tunable optical add/drop multiplexer," 6,438,293
- L. Eldada and R. A. Norwood, "Tunable optical add/drop multiplexer," 6,389,199
- R. A. Norwood, "Hybrid integrated optical add-drop multiplexer," 6,385,362
- B. Xu, R. A. Norwood, L. Eldada, and R. Blomquist, "Optical devices made from radiation curable fluorinated compositions." 6,306,563
- A. F. Garito, R. A. Norwood, R. Gao and A. Panackal, "Rare earth polymers, optical amplifiers and optical fibers." 6,292,292

- R. R. Dammel and R. A. Norwood, "Light-absorbing, antireflective layers with improved performance due to refractive index optimization." 6,274,295
- R. A. Norwood, B. Brown, J. Holman, and L. Shacklette, "Polymer gripping elements for optical fiber splicing." 6,266,472
- R. A. Norwood, M. Rudasill and D. Sossen, "Cascading of tunable optical filter elements." 6,256,428
- R. A. Norwood, J. Holman, S. Emo and L. Shacklette, "Micro-optic switch with lithographically fabricated polymer alignment features for the positioning of switch components and optical fibers." 6,169,827
- R. Dammel and R. A. Norwood, "Bottom antireflection coatings through refractive index modification by anomalous dispersion." 6,042,992
- G. Khanarian, R. Norwood, J. Sounik, J. Popolo, and S. Meyer, "Waveguide device and method for phase matched second harmonic generation." 5,224,196
- G. Khanarian and R. A. Norwood, "Thickness variation insensitive frequency doubling polymeric waveguide." 5,131,068
- G. Khanarian and R. A. Norwood, "Optical parametric amplifier." 5,064,265
- G. Khanarian, D. Haas, P. Landi, and R. A. Norwood, "Polymeric waveguides with bidirectional poling for radiation phasematching." 5,061,028
- G. Khanarian and R. A. Norwood, "Polymeric waveguide device for phase matched second harmonic generation." 4,971,416

Publications in Refereed Journals

- X. Yang, L. Zhang, Y. Feng, X. Zhu, R. A. Norwood, and N. Peyghambarian, "Mode-locked Ho³⁺-doped ZBLAN fiber laser at 1.2 μ m," *J. Lightwave Technology* **34**, 4266 (2016).
- T. S. Kleine, N. A. Nguyen, L. E. Anderson, S. Namnabat, E. A. Lavilla, S. A. Showgi, P. T. Dirlam, C. B. Arrington, M. S. Manchester, J. Schwiegerling, R. S. Glass, K. Char, R. A. Norwood, M. E. Mackay, and J. Pyun, "High refractive index copolymers with improved thermomechanical properties via the inverse vulcanization of sulfur and 1,3,5-triisopropenylbenzene," *ACS Macroletters* **5**, 1152 (2016).
- S. Shahin, P. Gangopadhyay, and R. A. Norwood, "Plasmonically induced potential in metal-semiconductor composites," *Advanced Optical Materials* DOI: 10.1002/adom.2011600428 (2016).
- J. Mei, K. Zhong, M. Wang, P. Liu, D. Xu, Y. Wang, W. Shi, J. Yao, R. A. Norwood, and N. Peyghambarian, "High-repetition rate terahertz generation in QPM GaAs with a compact efficient 2- μ m KTP OPO," *IEEE Photonics Tech. Lett.* **28**, 1501 (2016).
- D. Po, S. Shahin, W. Xie, S. Mehravar, X. Liu, C. Li, R. A. Norwood, J.-H. Lee, and J. J. Watkins, "Directed assembly of quantum dots using brush block copolymers for well-ordered nonlinear optical nanocomposites," *Macromolecules* **49**, 5068 (2016).
- S. Mehravar, R. A. Norwood, N. Peyghambarian, and K. Kieu, "Real-time dual-comb spectroscopy with a free-running bidirectionally mode-locked fiber laser," *Appl. Phys. Lett.* **108**, 231104 (2016).
- P. A. Blanche, B. Lynn, D. Churin, K. Kieu, R. A. Norwood, and N. Peyghambarian, "Diffraction response of photorefractive polymers over nine orders of magnitude of pulse duration," *Scientific Reports* **6**, 29027 (2016).
- G. Zhu, X. Zhu, F. Wang, S. Xu, Y. Li, X. Guo, K. Balakrishnan, R. A. Norwood, and N. Peyghambarian, "Graphene mode-locked fiber laser at 2.8 μ m," *IEEE Photonics Technology Letters* **28**, 7 (2016).
- J. Susoma, L. Karvonen, A. Saynatjoki, S. Mehravar, R. A. Norwood, N. Peyghambarian, K. Kieu, H. Kipsanen, and J. Riikonen, "Second and third harmonic generation in few-layer gallium telluride characterized by multiphoton microscopy," *Appl. Phys. Lett.* **108**, 073103 (2016).
- S. Fu, G. Shi, Q. Sheng, W. Shi, X. Zhu, J. Yan, R. A. Norwood, and N. Peyghambarian, "Dual-wavelength fiber laser operating above 2 μ m based on cascaded single-mode-multimode-single-mode fiber structures," *Optics Express* **24**, 11282 (2016).
- A. Miles, B. Cocilovo, B. Wheelwright, W. Pan, D. Tweet, and R. A. Norwood, "Designing spectrum-splitting dichroic filters to optimized current-matched photovoltaics," *Applied Optics* **55**, 1849 (2016).
- S. Mehravar, B. Banerjee, H. Chatrath, B. Amirsolaimani, K. Patel, C. Patel, R. A. Norwood, N. Peyghambarian, and K. Kieu, "Label-free multi-photon imaging of dysplasia in Barrett's esophagus," *Biomedical Optics Express* **7**, 148 (2016).
- B. Cocilovo, A. Hashimura, D. J. Tweet, T. Voutsas, and R. A. Norwood, "Highly transparent light-harvesting window film," *Applied Optics* **54**, 8990 (2015).
- R. Himmelhuber, R. A. Norwood, Y. Enami, and N. Peyghambarian, "Sol-gel material-enabled electro-optic polymer modulators," *Sensors* **15**, 18239 (2015).

- A. A. Khosroadbadi, P. Gangopadhyay, S. Hernandez, K. Kim, N. Peyghambarian, and R. A. Norwood, "Nanoimprinted hybrid metal-semiconductor plasmonic multilayers with controlled surface nano architecture for applications in NIR detectors," *Materials* **8**, 5028 (2015).
- S. Fu, Q. Sheng, X. Zhu, W. Shi, J. Yao, G. Shi, R. A. Norwood, and N. Peyghambarian, "Passive Q-switching of an all-fiber laser induced by the Kerr effect of multimode interference," *Optics Express* **23**, 17255 (2015).
- P. Liu, W. Shi, D. Xu, X. Zhang, J. Yao, R. A. Norwood, and N. Peyghambarian, "High-power high-brightness terahertz source based on nonlinear optical crystal fiber," *IEEE J. Selected Topics in Quantum Electronics* **22**, 4900606 (2015).
- A. Jones, C. T. DeRose, A. L. Lentine, A. Starbuck, A. T. S. Pomerene, and R. A. Norwood, "Racetrack resonator as a loss measurement platform for photonic components," *Optics Express* **23**, 28883 (2015).
- R. Gowda, N. Nguyen, J.-C. Diels, R. A. Norwood, N. Peyghambarian, and K. Kieu, "All-fiber bidirectional optical parametric oscillator for precision sensing," *Optics Letters* **40**, 2033 (2015).
- D. Churin, J. Olson, R. A. Norwood, N. Peyghambarian, and K. Kieu, "High-power synchronously pumped femtosecond Raman fiber laser," *Optics Letters* **40**, 2529 (2015).
- G. Zhu, L. Geng, X. Zhu, L. Li, Q. Chen, R. A. Norwood, T. Manzur, and N. Peyghambarian, "Towards ten-watt 3-5 μm Raman lasers using tellurite fiber," *Optics Express* **23**, 7559 (2015).
- L. Karvonen, A. Saynatjoki, S. Mehravar, R. D. Rodriguez, S. Hartmann, D. R. T. Zahn, S. Honkanen, R. A. Norwood, N. Peyghambarian, K. Kieu, H. Lipsanen, and J. Riikonen, *Scientific Reports* **5**, 10334 (2015).
- J. Griebel, N. A. Nguyen, S. Namnabat, L. E. Anderson, R. S. Glass, R. A. Norwood, M. E. Mackay, K. Char, and J. Pyun, "Dynamic covalent polymers via inverse vulcanization of elemental sulfur for healable infrared optical materials," *ACS Macro Letters* **4**, 862 (2015).
- B. Cocilovo, O. D. Herrera, S. Mehravar, Y. Fang, K. H. Sandhage, K. Kieu, and R. A. Norwood, "Surface-enhanced two-photon excitation fluorescence of various fluorophores evaluated using a multiphoton microscope," *Journal of Lightwave Technology* **33**, 3446 (2015).
- B. Lynn, A. Miles, S. Mehravar, P.-A. Blanche, K. Kieu, R. A. Norwood, and N. Peyghambarian, "Real-time imaging of chromophore alignment in photorefractive polymer devices through multiphoton microscopy," *MRS Communications* doi:10.1557/lmrc2015.31 (2015).
- S. Liu, X. Zhu, G. Zhu, K. Balakrishnan, J. Zong, K. Wiersma, A. Chavez-Pirson, R. A. Norwood, and N. Peyghambarian, "Graphene Q-switched Ho^{3+} -doped ZBLAN fiber laser at 1190nm," *Opt. Lett.* **40**, 147 (2015).
- S. Shahin, S. Mehravar, P. Ganopadhyay, N. Peyghambarian, R. A. Norwood, and K. Kieu, "Multiphoton microscopy as a detection tool for photobleaching in EO materials," *Optics Express* **22**, 30955 (2014).
- S. Shahin, K. Kieu, J. M. Hales, H. Kim, Y. A. Getmanenko, Y. Zhang, J. W. Perry, S. R. Marder, R. A. Norwood, and N. Peyghambarian, "Third-order nonlinear optical characterization of organic chromophores using liquid-core optical fibers," *J. Opt. Soc. Am. B* **31**, 2455 (2014).
- G. Zhu, X. Zhu, R. A. Norwood, and N. Peyghambarian, "Experimental and numerical investigations on Q-switched laser-seeded fiber MOPA at 2.8 μm ," *J. Lightwave Technol.* **32**, 3951 (2014).
- A. A. Khosroadbadi, D. L. Matz, P. Gangopadhyay, J. E. Pemberton, and R. A. Norwood, "Study of the C_{60}/Ag interface of a large area nanoarchitected Ag substrate using surface-enhanced Raman scattering," *J. Phys. Chem. C* **118**, 18027 (2014).
- W. Shi, Q. Fang, X. Zhu, R. A. Norwood, and N. Peyghambarian, "Fiber lasers and their applications," *Applied Optics* **53**, 6554 (2014).
- V. Demir, R. Voorakaranam, R. Himmelhuber, O. D. Herrera, R. A. Norwood, and N. Peyghambarian, "Microwave properties of MAPTMS sol-gel films for high-speed electrooptic devices," *IEEE Trans. Microwave Theory & Techniques* **62**, 1599 (2014).
- H. Watarai, P. Gangopadhyay, R. A. Norwood, and N. Peyghambarian, "Total internal reflection magneto-optical detection of dysprosium (III) ions adsorbed at liquid-liquid interface," *Chemistry Letters* **43**, 1651 (2014).
- B. Duong†, H. Khurshid†, P. Gangopadhyay†, J. Devkota, K. Stojak, H. Srikanth, L. Tetard, R. A. Norwood, N. Peyghambarian, M.-H. Phan and J. Thomas, "Enhanced magnetism in highly ordered magnetite nanoparticle-filled nanohole arrays" *Small* **10**, 2840 (2014).
- D. T. Nguyen and R. A. Norwood, "A novel approach for microsensing: Detecting and identifying eigenmodes of sensing objects," *Journal of Analytical and Bioanalytical Techniques* <http://dx.doi.org/10.4172/2155-9872.S7-015> (2014).

- K. Kieu, C. Li, Y. Fang, G. Cohoon, O. D. Herrera, M. Hildebrand, K. H. Sandhage, and R. A. Norwood, "Structure-based optical filtering by the silica microshell of the centric marine diatom *Cosconodiscus wailessi*," *Optics Express* **22**, 15992 (2014).
- X. Zhu, J. Zong, K. Wiersman, R. Norwood, N. Prasad, M. Obland, A. Chavez-Pirson, and N. Peyghambarian, "Watt-level short-length Ho³⁺-doped ZBLAN fiber laser at 1.2 μm," *Opt. Lett.* **39**, 1533 (2014).
- N. S. Makarov, P. C. Lau, C. Olson, K. A. Vlizhanin, K. M. Solntsev, K. Kieu, S. Kilina, S. Tretiak, R. A. Norwood, N. Peyghambarian, and J. W. Perry, "Two-photon absorption in CdSe colloidal quantum dots compared to organic molecules," *ACS Nano* **8**, 12572 (2014).
- P. C. Lau, R. A. Norwood, M. Mansuripur, and N. Peyghambarian, "An effective nanosensor for organic molecules based on water-soluble mercaptopropionic acid-capped CdTe nanocrystals with potential application in high-throughput screening and high-resolution optical microscopy," *Biomedical Optics Express* **5**, 2420 (2014).
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- G. A. Cohoon, K. Kieu, and R. A. Norwood, "Observation of two-photon fluorescence for Rhodamine 6G in microbubble resonators," *Optics Letters* **39**, 3098 (2014).
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- V. Demir, P. Gangopadhyay, R. A. Norwood, and N. Peyghambarian, "Faraday rotation of cobalt ferrite nanoparticle polymer composite films at cryogenic temperature," *Applied Optics* **53**, 2087 (2014).
- B. Duong, H. Khurshid, P. Gangopadhyay, J. Devkota, K. Stojak, H. Srikanth, L. Tetard, R. A. Norwood, N. Peyghambarian, M.-H. Phan, and J. Thomas, "Enhanced magnetism in highly ordered magnetite nanoparticle-filled nanohole arrays," *Small* DOI: 10.1002/smll.201303809 (2014).
- J. Griebel, S. Namnabat, E. T. Kim, R. Himmelhuber, D. Moranta, W. J. Chung, A. G. Simmonds, K.-J. Kim, J. van der Laan, N. A. Nguyen, E. L. Dereniak, M. E. Mackay, K. Char, R. S. Glass, R. A. Norwood, and J. Pyun, "New infrared transmitting material via inverse vulcanization of elemental sulfur to prepare high refractive index polymer," *Advanced Materials* **26**, 3014 (2014).
- O. D. Herrera, L. Schneebeli, K. Kieu, R. A. Norwood, and N. Peyghambarian, "Raman-induced frequency shift in CS₂ filled integrated liquid-core optical fiber," *Optics Communications* **318**, 83 (2014).
- J. He, R. A. Norwood, M. Brandt-Pearce, I. B. Djordjevic, M. Cvijetic, S. Subramanian, R. Himmelhuber, C. Reynolds, P. Blanche, B. Lynn, and N. Peyghambarian, "A survey on recent advances in optical communications," *Computers and Electrical Engineering* (in press, January 2014).
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- R. A. Norwood, "Integrated photonics: The right tool for more jobs," **invited talk** at Raytheon Engineers on the Go LeSeries (September 20, 2016).
- P.-A. Blanche, B. Lynn, R. A. Norwood, and N. N. Peyghambarian, "Mechanisms for the reciprocity failure in photorefractive polymers," *SPIE Optics and Photonics 2016* (San Diego, CA, August 28 – September 1, 2016) paper 9939-19 (2016).
- R. A. Norwood, "Nanocomposites and nanostructured materials for integrated photonics," **invited talk** at *Telluride Nanomaterials Meeting* (Telluride, CO, July 31 – August 4, 2016).
- L. E. Anderson, S. Namnabat, R. A. Norwood, and J. Pyun, "Ultra high refractive index polymers for IR optics," *OSA NOMA Topical Meeting 2016* (Vancouver, BC, July 18 – July 20, 2016), paper NoM4C.2 (2016).
- L. E. Anderson, S. Namnabat, K. Char, R. Glass, R. A. Norwood, and J. Pyun, "Ultrahigh refractive index chalcogenide based copolymers for infrared optics," *SPIE Optics and Photonics 2016* (San Diego, CA, August 28 – September 1, 2016) paper 9939-18 (2016).
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- A. Autere, A. Saynatjoki, L. Karvonen, B. Amirsolaimani, H. Jussila, H. Yang, R. Norwood, N. Peyghambarian, H. Lipsanen, and K. Q. Kieu, "Direct comparison of second and third harmonic

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 - C. E. Alvarez, R. A. Norwood, K. Q. Kieu, G. A. Cohoon, and O. Kropacheva, "Surface-enhanced Raman scattering in *C. walesii* diatom frustules," *SPIE Photonics West 2016* (San Francisco, CA, February 13-18, 2016), paper 9756-77 (2016).
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- R. A. Norwood, "Hybrid integrated optical isolators," **invited talk** at *SPIE Photonics West* (January 21-26, 2012, San Francisco, CA).
- R. A. Norwood, "Engineered particles for photonics: From nano to micro," **invited talk** at *Composites at Lake Louise* (Oct. 31 – Nov. 3, 2011, Lake Louise, Alberta, Canada).
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