

Robert A. Norwood

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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
- IEEE – Institute for Electronics and Electrical Engineers

University of Arizona: Long—Term Research Goals

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

University of Arizona: Current Funded Research Projects

- Electro-optic polymers and devices
 - L3Harris Corporation, "High Index Electroactive Polymer Development," PI (2020)
- Photonics Manufacturing
 - AIM Photonics, TAP program "High Throughput Manufacturing for PIC Polymer Waveguide Connection," co-PI (2016 - 2020)
 - AIM Photonics, Cryogenic FPA program, "Development of a Prototype FPA Cryogenic Integrated Photonic Datalink Using Wavelength Division Multiplexing Silicon Disk Modulators," PI (2017 – 2020)
- Optical Materials
 - National Science Foundation, "Chalcogenide-based Hybrid Polymers with High Refractive Index for IR Thermal Imaging," co-PI (2016 - 2020)

- National Science Foundation, "Translational Research with Chalcogenide Hybrid Inorganic/Organic Polymers (CHIPs) for Infrared Imaging and Sensing Technologies," co-PI (2020-2023)
 - MOBASE Corporation, "Novel Chalcogenide Hybrid Inorganic/Organic Polymers (CHIPs) and Nanocomposites Materials for Next Generation IR Thermal Imaging Systems," co-PI (2018-2020)
- Solar energy
 - DOE RAPID, "A Hybrid Optical Technology for Concentrate Management," co-PI (2020-2022)

University of Arizona: Additional Research Interests

- Sol-gels
- Polymer optical interconnects
- Infrared optical materials
- Silicon photonics
- Polymer/nanoparticle composites
- Solar energy systems
- Fiber lasers
- Liquid photonics
- Plasmonics
- Tunable optical filters
- Multiphoton microscopy of 2D materials
- Nonlinear optical materials
- Engineered dielectric materials
- Materials for advanced photolithography
- 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 - 2018
- Member: Program Committee *CLEO* 2017-2019
- *IEEE Photonics Technology Letters*, Associate Editor 2010 – 2013

- *Optical Materials Express*, Associate Editor 2011 – 2013
- *Nature Photonics*, Reviewer
- *Applied Physics Letters*, Reviewer
- *Chemistry of Materials*, Reviewer
- *IEEE Journal of Quantum Electronics*, Reviewer
- *Journal of the Optical Society of America B*, Reviewer
- *Optics Letters*, Reviewer
- Member: Committee, OSA *Optical Materials Studies Technical Group* 2015 - 2019
- Member: Program Committee, *Photonics in Switching*, 2014-2020
- Member: Program Committee, SPIE *Organic Photonic Materials and Devices* 2010-2016
- Member: Program Committee, SPIE *Integrated Optics: Devices, Materials and Technologies*, 2014 - present
- OSA Fellows Committee Chair 2010
- OSA Fellows Committee Member 2009
- Conference Chair: SPIE *Linear and Nonlinear Optical Properties of Organic Materials VI* 1999-2006
- Chair: Subcommittee D, *Optical Switching and Wavelength Routing Devices*, OFC 2006
- Member: Program Committee, OFC 2003 - 2005
- Member: Program Committee, CLEO 2002 - 2004
- Member: Program Committee, SPIE *Polymer Photonic Devices* 1998-2003
- Member: Program Committee, OSA/ACS *Organic Thin Films '01* 1998 - 2002
- Program Co-Chair: OSA/ACS *Organic Thin Films* 1999-2000

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

- R. S. Witte, L. G. Montilla, R. Olafsson, C. M. Ingram, Z. Wang, R. A. Norwood, C. Greenlee, "Ultrasonic/photoacoustic imaging devices and methods," 10,241,199
- R. A. Norwood, K. Q. Kieu, and R. Himmelhuber, "SHG imaging technique for assessing hybrid EO polymer/silicon photonic integrated circuits," 9,645,045
- P. Gangopadhyay, R. A. Norwood, A. A. Miles, J. Kato, S. Virji, and M. Miyawaki, "Method of purifying nanodiamond powder and purified nanodiamond powder," 9,446,956.
- P. Gangopadhyay, A. Lopez-Santiago, and R. A. Norwood, "Magnetic-core polymer-shell nanocomposites with tunable magneto-optical and/or optical properties," 9,378,880.
- 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

- N. G. Pavlopoulos, K. S. Kang, L. N. Holmen, N. P. Lyons, F. Akhouni, K. J. Carothers, S. L. Jenkins, T. Lee, T. M. Kochenderfer, A. Phan, D. Phan, M. E. Mackay, I. B. Shim, K. Char, N. Peyghambarian, L. J. Lacombe, R. A. Norwood, and J. Pyun, "Polymer and magnetic nanoparticle composites with tunable magneto-optical activity: role of nanoparticle dispersion for high Verdet constant materials," *J Mater. Chem. C* **8**, 5417 (2020).
- M. Mollaei, X. Zhu, S. Jenkins, J. Zong, E. Temyanko, R. Norwood, A. Chavez-Pirson, M. Li, D. Zelmon, and N. Peyghambarian, "Magneto-optical properties of highly Dy³⁺ doped multicomponent glasses," *Optics Express* **28**, 11789 (2020).
- T. S. Kleine, J. I. Frish, N. G. Pavlopoulos, S. A. Showghi, R. Himmelhuber, R. A. Norwood, and J. Pyun, "Refractive index contrast polymers: Photoresponsive systems with spatial modulation of refractive index for photonics," *ACS Macroletters* **9**, 416 (2020).
- T. S. Kleine, R. S. Glass, D. L. Lichtenberger, M. E. Mackay, K. Char, R. A. Norwood, and J. Pyun, "100th Anniversary of Macromolecular Science Viewpoint: High refractive index polymers with elemental sulfur for infrared thermal imaging and optics," *ACS Macroletters* **9**, 245 (2020).
- T. S. Kleine, T. Lee, K. J. Carothers, M. O. Hamilton, L. E. Anderson, L. Ruiz Diaz, N. P. Lyons, K. R. Coasey, W. O. Parker, Jr., L. Borghi, M. E. Mackay, K. Char, R. S. Glass, D. L. Lichtenberger, R. A. Norwood, and J. Pyun, "Infrared fingerprint engineering: A molecular design approach to long-wave infrared transparency with polymeric materials," *Angewandte Chemie* **131**, 1 (2019).
- J. Wu, X. Zhu, C. Xia, H. Wei, K. Wiersma, M. Li, J. Zong, A. Chavez-Pirson, R. A. Norwood, and N. Peyghambarian, "Investigation of ion-ion interaction effects on Yb³⁺-doped fiber amplifiers," *Optics Express* **27**, 28179 (2019).
- Y. Ma, X. Zhu, L. Yang, M. Tong, R. A. Norwood, H. Wei, Y. Chu, H. Li, N. Dai, J. Peng, J. Li and N. Peyghambarian, "Numerical investigation of GHz repetition rate fundamentally mode-locked all-fiber lasers," *Optics Express* **27**, 14487 (2019).
- F. Akhouni, R. A. Norwood, and N. Peyghambarian, "Low-cost magneto-optic sensor based on tapered fiber and distributed sensing concept," *IEEE Phot. Tech. Lett.* **31**, 901 (2019).
- S. Arouh, R. Himmelhuber, and R. A. Norwood, "SiO₂ and TiO₂ blends with tunable optical and electronic properties," *MRS Advances* **4**, 689 (2019).
- S. Cui, N. P. Lyons, L. Ruiz Diaz, R. Ketchum, K.-J. Kim, H.-C. Yuan, M. Frasier, W. Pan, and R. A. Norwood, "Silicone optical elements for cost-effective freeform solar concentration," *Optics Express* **27**, A572 (2019).
- T. S. Kleine, L. Ruiz-Diaz, K. M. Konopka, L. E. Anderson, N. G. Pavlopoulos, N. P. Lyons, E. T. Kim, Y. Kim, R. S. Glass, K. Char, R. A. Norwood, and J. Pyun, "One-dimensional photonic crystals using ultrahigh refractive index chalcogenide hybrid inorganic/organic polymers," *ACS Macro Letters* **7**, 875 (2018).
- M. Babaeian, P. Kieffer, M. A. Neifeld, R. Thamvichal, R. A. Norwood, P.-A. Blanche, J. Wissinger, and N. Peyghambarian, "Optical versus electronic implementation of probabilistic graphical inference and experimental device demonstration using nonlinear photonics," *IEEE Phot. Jour.* **10**, 7801412 (2018).
- M. Babaeian, P.-A. Blanche, R. A. Norwood, T. Kaplas, P. Kieffer, Y. Svirko, T. G. Allen, V. W. Chen, S.-H. Chi, J. W. Perry, S. R. Marder, M. A. Neifeld, and N. Peyghambarian, "Nonlinear optical components for all-optical probabilistic graphical model," *Nature Communications* **9**, 2128 (2018).
- M. Babaeian, L. Ruiz Diaz, S. Namnabat, T. S. Kleine, A. Azarm, J. Pyun, N. Peyghambarian, and R. A. Norwood, "Nonlinear optical properties of chalcogenide hybrid inorganic/organic polymers (CHIPs) using the Z-scan technique," *Optical Materials Express* **8**, 2510 (2018).
- B. Amirsolaimani, P. Gangopadhyay, A. P. Persoons, S. A. Showghi, L. J. Lacombe, R. A. Norwood, and N. Peyghambarian, *Optics Letters* **43**, 4615 (2018).
- A. Autere, H. Jussila, A. Marini, J.R.M. Saavedra, Y. Dai, A. Säynätjoki, L. Karvonen, H. Yang, B. Amirsolaimani, R. A. Norwood, N. Peyghambarian, H. Lipsanen, K. Kieu, F. Javier Garcia De Abajo, and Z. Sun, "Optical harmonic generation in monolayer group-VI transition metal dichalcogenides," *Phys. Rev. B.* **98**, 115426 (2018).
- L. Ruiz Diaz, B. Cocilovo, A. Miles, W. Pan, P.-A. Blanche, and R. A. Norwood, "Optical and mechanical tolerances in hybrid concentrated thermal-PV solar trough," *Optics Express* **26**, A602 (2018).
- J. Wu, X. Zhu, K. Wiersma, M. Li, J. Zong, A. Chavez-Pirson, V. Temyanko, L. J. LaComb, R. A. Norwood, and N. Peyghambarian, "Power scalable 10W 976nm single-frequency linearly polarized laser source," *Optics Letters* **43**, 951 (2018).
- V. P. Drachev, A. V. Kildishev, J. D. Borneman, K.-P. Chen, V. M. Shalaev, K. Yamnitskiy, R. A. Norwood, N. Peyghambarian, S. R. Marder, L. A. Padilha, S. Webster, T. R. Ensley, D. J. Hagan, and E. W. Van Stryland, "Engineered nonlinear materials using gold nanoantenna array," *Scientific Reports* **8**, 780 (2018).

- S. Namnabat, K.-J. Kim, A. Jones, R. Himmelhuber, C. T. DeRose, D. C. Trotter, A. L. Starbuck, A. Promene, A. L. Lentine, and R. A. Norwood "Athermal silicon optical add-drop multiplexers based on thermo-optic coefficient tuning of sol-gel material," *Opt. Exp.* **25**, 21471 (2017).
- L. Karvonen, A. Saynatjoki, M. J. Huttunen, A. Autere, B. Amirsolaimani, S. Li, R. A. Norwood, N. Peyghambarian, H. Lipsanen, G. Eda, K. Kieu, and Z. Sun, "Rapid visualization of grain boundaries in monolayer MoS₂ by multiphoton microscopy," *Nature Communications* **8**, 15714 (2017).
- J. Luo, D. H. Park, R. Himmelhuber, Z.-L. Zhu, M. Li, R. A. Norwood, and A. K.-Y. Jen, "Efficient wafer-scale poling of electro-optic polymer thin films on soda-lime glass substrates: large second-order nonlinear coefficients and exceptional homogeneity of optical birefringence," *Optical Materials Express* **7**, 1909 (2017).
- A. Säynätjoki, L. Karvonen, H. Rostami, A. Autere, S. Mehravar, A. Lombardo, R. A. Norwood, T. Hasan, N. Peyghambarian, H. Lipsanen, K. Kieu, A. C. Ferrari, M. Polini, and Z. Sun, "Ultra-strong nonlinear optical processes and trigonal warping in MoS₂ layers," *Nature Communications* **8**, 893 (2017).
- A. Miles, Y. Gai, P. Gangopadhyay, X. Wang, R. A. Norwood, and J. J. Watkins, "Improving Faraday rotation performance with block copolymer and FePt nanoparticle magneto-optical composite," *Optical Materials Express* **7**, 2126 (2017).
- L. E. Anderson, T. S. Kleine, Y. Zhang, D. D. Phan, S. Namnabat, E. A. LaVilla, K. M. Konopka, L. Ruiz Diaz, M. S. Manchester, J. Schwiegerling, R. S. Glass, M. E. Mackay, K. Char, R. A. Norwood, and J. Pyun, "Chalcogenide hybrid inorganic/organic polymers: Ultrahigh refractive index polymers for infrared imaging," *ACS Macroletters* **6**, 500 (2017).
- J. Wu, X. Zhu, V. Temyanko, L. LaComb, L. Kotov, K. Kiersma, J. Zong, M. Li, A. Chavez-Pirson, R. A. Norwood, and N. Peyghambarian, "Yb³⁺-doped double-clad phosphate fiber for 976nm single-frequency laser amplifiers," *Opt. Mat. Express* **7**, 1310 (2017).
- 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. Sel. Top. Quant. Ele.* **22**, 8500105 (2016).
- J. Mei, K. Zhong, M. Wang, Y. Liu, D. Xu, W. Shi, Y. Wang, J. Yao, R. A. Norwood, and N. Peyghambarian, "Widely-tunable high-repetition-rate terahertz generation in GaSe with a compact dual-wavelength KTP OPO around 2 μm," *Optics Express* **24**, 23368 (2016).
- X. Yang, L. Zhang, Y. Feng, X. Zhu, R. A. Norwood, and N. Peyghambarian, "Mode-locked Ho³⁺-doped ZBLAN fiber laser at 1.2 μm," *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).
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- 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 μm based on cascaded single-mode-multimode-single-mode fiber structures," *Optics Express* **24**, 11282 (2016).

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- B. Cocilovo, A. Hashimura, D. J. Tweet, T. Voutsas, and R. A. Norwood, "Highly transparent light-harvesting window film," *Applied Optics* **54**, 8990 (2015).
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Presentations, Invited Talks, Proceedings, and Other Publications

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- A. Nishant, M. Babaeian, K.-J. Kim, T. S. Kleine, J. A. Meise, J. Pyun, and R. A. Norwood, "Chalcogenide hybrid inorganic/organic polymers (CHIPs) based optical waveguides for integrated nonlinear photonics applications," *SPIE Photonics West 2020* (San Francisco, CA, February 1 – February 6, 2020), Paper 11283-44 (2020).
- R. A. Norwood, "Sulfur and selenium-based polymers for infrared optics and photonics," *invited talk at Novel Optical Materials and Applications* (San Francisco, July 29 – Aug. 1, 2019).
- R. A. Norwood, E. Fard, K.-J. Kim, C. Long, A. Lentine, M. C. Thomas, F. B. Jaworski, and P. J. Smith, "High-speed read-out of cryogenic focal plane arrays," *invited paper at GoMac Tech 2019* (Albuquerque, NM, March 26, 2019).
- R. A. Norwood, "Optics: The Engine of the Information Age," Nanotechnology Seminar at UCF NanoScience Technology Center (University of Central Florida, March 8, 2019).
- R. A. Norwood, "Polymer optical interconnects for silicon and silicon-nitride photonics," *invited talk at SPIE Photonics West 2019* (San Francisco, CA, February 2 -7, 2019), Paper 10924-19 (2019).
- J. I. Frish, T. S. Kleine, R. Himmelhuber, J. Pyun, and R. A. Norwood, "Preparation of novel t-BoC protected styrenic sulfides with phototunable refractive indices for integrated optics," *SPIE Photonics West 2019* (San Francisco, CA, February 2 -7, 2019), Paper 10921-63 (2019).

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