

## 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:
  - Wyant College of Optical Sciences, Professor, 2009 - present
  - Wyant College of Optical Sciences, Research Professor, 2004-2009
  - College of Engineering, Department of Materials Science and Engineering, Professor, 2018-present
- 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

- National Academy of Inventors (NAI), **Fellow**
- 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 (2020-2022)
- Photonics devices and networks
  - National Science Foundation, "A Unified Framework for the Emulation of Classical and Quantum Physical Layer Networks," co-PI (2021 - 2025)
  - Sandia National Laboratories, "Integrated Photonics at SWIR Wavelengths," PI (2021-2022)
- Optical materials
  - National Science Foundation, "DMREF: Computational Chemistry to Accelerate Development of Long Wave Infrared Polymers," co-PI (2021 - 2026)

- National Science Foundation, "Translational Research with Chalcogenide Hybrid Inorganic/Organic Polymers (CHIPs) for Infrared Imaging and Sensing Technologies," co-PI (2020-2023)
- National Science Foundation, "Sulfonyl Chloride Electrophilic Addition to Olefinic Monomers: A New Step-Growth Polymerization Reaction to Prepare Optical Polymers," co-PI (2022 - 2025)
- Azimuth Corporation (for AFRL), "Synthesis and Characterization of Novel Sulfur Based Optical Polymers," (2021-2022)
- Solar energy/Optical engineering
  - DOE RAPID, "A Hybrid Optical Technology for Concentrate Management," co-PI (2020-2022)
  - iCrx, "Cylindrical Lens Design and Fabrication" (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

- A. Nishant, K.-J. Kim, S. A. Showghi, R. Himmelhuber, T. S. Kleine, T. Lee, J. Pyun, and R. A. Norwood, "High refractive index chalcogenide hybrid inorganic/organic polymers for integrated photonics," *Advanced Optical Materials* **2022**, 2200176 (2022).
- J. I. Frish, T. S. Kleine, R. Himmelhuber, S. Showghi, A. Nishant, K.-J. Kim, L. Jiang, K. P. Martin, L. Brusberg, S. Pau, T. L. Koch, J. Pyun, and R. A. Norwood, "Rapid photolithographic fabrication of high density optical interconnects using refractive index contrast polymers," *Optical Materials Express* **12**, 1932 (2022).
- L. Jiang, A. Nishant, J. Frish, T. S. Kleine, L. Brusberg, R. Himmelhuber, K.-J. Kim, J. Pyun, S. Pau, R. A. Norwood, and T. L. Koch, "SmartPrint single-mode flexible polymer optical interconnect for high density integrated photonics," *IEEE J. Lightwave Technology* **40**, 3839 (2022).
- J. Wang, X. Zhu, R. A. Norwood, and N. Peyghambarian, "Widely wavelength tunable Dy<sup>3+</sup>/Er<sup>3+</sup> ZBLAN fiber lasers," *Optics Express* **29**, 38646 (2021).
- S. Fu, X. Zhu, J. Zong, R. A. Norwood, and N. Peyghambarian, "Diode-pumped 1.15W linearly polarized single-frequency Yb<sup>3+</sup>-doped phosphate fiber laser," *Optics Express* **29**, 30637 (2021).
- S. L. Jenkins, S. A. Showghi, and R. A. Norwood, "Optical tuning of Si<sub>3</sub>N<sub>4</sub> ring resonators using an external short visible wavelength laser source," *OSA Continuum* **4**, 1669 (2021).
- E. M. Fard, S. Namnabat, S. Arouh, R. A. Norwood, S. Pau, and N. Peyghambarian, "Relaxed tolerance low-loss adiabatic Si<sub>3</sub>N<sub>4</sub> to polymer waveguide coupler for dense interconnects," *IEEE Phot. Tech. Lett.* **33**, 1227 (2021).
- J. Wang, X. Zhu, R. A. Norwood, and N. Peyghambarian, "Beyond 3μm Dy<sup>3+</sup>/Er<sup>3+</sup> co-doped ZBLAN fiber lasers pumped by 976nm laser diode," *Appl. Phys. Lett.* **118**, 151101 (2021).
- K.J. Carothers, N. P. Lyons, N. G. Pavlopoulos, K.-S. Kang, T. M. Kochenderfer, A. Phan, L. N. Holmen, S. L. Jenkins, I.-B. Shim, R. A. Norwood, and J. Pyun, "Polymer-coated magnetic nanoparticles as ultra-high Verdet constant materials: Correlation of nanoparticle size with magnetic & magneto-optical properties," *Chemistry of Materials* **33**, 5010 (2021).
- S. Fu, X. Zhu, J. Zong, M. Li, I. Zavala, V. Temyanko, A. Chavez-Pirson, R. A. Norwood, and N. Peyghambarian, "Single-frequency Nd<sup>3+</sup>-doped phosphate fiber laser at 915nm," *J. Lightwave Tech.* **39**, 1808 (2021).
- R. S. Ketchum, H.-C. Yuan, L. Ruiz-Diaz, N. P. Lyons, S. Cui, M. Frasier, S. A. Showghi, K.-J. Kim, A. Ida, W. Pan, and R. A. Norwood, "Design and characterization of a translucent solar module (TSM) for greenhouse structures," *J. Engineering and Architecture* **8**, 42 (2020).
- N. P. Lyons, S. Cui, R. S. Ketchum, K.-J. Kim, and R. A. Norwood, "Thermal compensation of molded silicone optics," *Applied Optics* **59**, G59 (2020).
- N. G. Pavlopoulos, K. S. Kang, L. N. Holmen, N. P. Lyons, F. Akhoundi, 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).
- S. Fu, X. Zhu, J. Wang, J. Zong, M. Li, A. Chavez-Pirson, R. A. Norwood, and N. Peyghambarian, "High-efficiency Nd<sup>3+</sup>-doped phosphate fiber laser at 880nm," *IEEE Phot. Tech. Lett.* **32**, 1179 (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 Dy<sup>3+</sup> doped multicomponent glasses," *Optics Express* **28**, 11789 (2020).
- E. M. Fard, C. M. Long, A. L. Lentine, and R. A. Norwood, "Cryogenic C-band wavelength division multiplexing system using an AIM Photonics Foundry process design kit," *Optics Express* **28**, 35551 (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 Yb<sup>3+</sup>-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. Akhoundi, 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, "SiO<sub>2</sub> and TiO<sub>2</sub> 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. Pavlopolous, 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).
  - 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 MoS<sub>2</sub> 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 MoS<sub>2</sub> 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).

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- R. A. Norwood, "Micro/nanofabrication of chalcogenide hybrid inorganic-organic polymer for infrared photonics applications," *invited talk* at *SPIE Photonics West 2021* (March 5, 2021), *Proc.* 11696 (2021).
- R. A. Norwood, "Polymer optical interconnects for silicon photonics: towards optical printed circuit boards," *invited talk* at *SPIE Photonics West 2021* (March 5, 2021), *Proc.* 11692 (2021)
- S. Cui, R. S. Ketchum, N. P. Lyons, K.-J. Kim, and R. A. Norwood, "Optical polymer solar concentrators for compact CPV systems," *Proc. AIP* **2298**, 050001 (2020).
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