

Zane Coleman

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OPTICAL TECHNOLOGY EXPERT

PROFILE

- Optical technology, lighting, and display expert
- Inventor on 56 issued patents, Inventor on 25+ pending patent applications
- Expertise and analytical skills for optical and physical product analysis
- USPTO Registered Patent Agent

EMPLOYMENT

Phostech **President** 2009 – Present

- Optical consulting, Patent prosecution services
- Expert declarations (3) and deposition for Petitioners Technical Consumer Products, Inc., Nicor Inc., Amax Lighting, Inc. in IPR petitions for LSG Corp. LED light fixture patents
- Expert declarations related to LED light fixtures in in Ultravision Technologies, LLC v. Lamar Advertising Co.
- Submitted declarations for 12 USPTO *Inter partes* reviews related to backlights and light fixtures
- Expert declaration, deposition in Morgan Solar, Inc. v. Banyan Energy Inc., USPTO PTAB Interfer No. 105,972
- Invented backlights, flexible lightguide technology, waveguides, LED bulbs based on waveguides, LED light fixture configurations, concentrating solar collection systems, other illumination devices

Fusion Optix Inc. **VP Technology & Dir. of Technology** 2006-2009

Led the research strategy and transfer of technology to product engineering in a fast-paced small company providing innovation in the display and LED lighting industries

- Developed technology roadmaps, intellectual property strategy, & competitive benchmarking
- Invented more than 35 unique, patentable products and drafted & prosecuted 60+ patent applications
- Managed and researched optical films, display backlights, LED light fixture, and LED light bulb projects
- Co-developed the optical system of a Lightfair 2009 Innovation Award-winning LED light fixture

Manager, Optical Engineering 2005-2006

- Developed and prototyped micro-replicated, multi-functional optical films for displays and light fixtures through optical modeling, prototyping, optical and thermal analysis, and specification
- Designed and managed optical film, LED backlight, and light fixture optical and thermal characterization lab
- Led polymer based optical film research including production and optical characterization

Phostech **President** 2003-2005

- Optical design & analysis of diffusing films, refractive-TIR films, displays, LCD backlights, lightguides, illuminated signs and light fixtures
- Invented new optical films, light fixtures, projection screens, backlights and displays

Motorola Labs **Senior Physicist** 1997-2002

- Optically designed & constructed world's first personal micro-projector (US Patent 6,637,896)
- Designed reflection and transmission micro-structured optical films for display backlights and illumination
- Designed and developed 3 new optical film products with suppliers, including an optical film with 3M which was shipped in over 100 million cellular phones
- Analyzed thermal and optical properties of products including developing new measurement techniques
- 4 issued Patents, 26 patent disclosures

ImEdge Technology Inc. **Optical Engineer** 1993-1997

- Co-invented new methods for recording edge-lit lightguide based holograms and edge-lit devices for display illumination and biometric applications (7 issued patents)
- Modeled, recorded, and performed optical and thermal analysis of optical components and systems

EDUCATION

Ph.D. in Physics, Loughborough University (UK) 1997

Applied rigorous coupled wave diffraction theory to model and analyze recorded edge-lit holograms

BSc. in Applied Physics, Certificate in Optics, Georgia Institute of Technology 1992

Issued Patents

- 1) KR10-1821727 Front illumination device comprising a film-based lightguide
- 2) 9,804,607 Fluid transfer systems, devices, components, and methods of manufacture
- 3) 9,798,075 Film-based light fixture with see-through light emitting region
- 4) 9,690,032 Lightguide including a film with one or more bends
- 5) JP6132762 Front illumination device comprising a film-based lightguide
- 6) 9,651,729 Reflective display comprising a frontlight with extraction features and a light redirecting optical element
- 7) 9,645,304 Directional front illuminating device comprising a film based lightguide with high optical clarity in the light emitting region
- 8) 9,566,751 Methods of forming film-based lightguides
- 9) 9,557,473 Reflective spatial light modulator display with stacked lightguides and method
- 10) 9,523,807 Device comprising a film-based lightguide and component with angled teeth
- 11) 9,110,200 Illumination device comprising a film-based lightguide
- 12) 9,103,956 Light emitting device with optical redundancy
- 13) 9,028,123 Display illumination device with a film-based lightguide having stacked incident surfaces
- 14) 8,958,698 Versatile remote control device and system
- 15) 8,950,902 Light emitting device with light mixing within a film
- 16) 8,917,962 Method of manufacturing a light input coupler and lightguide
- 17) 8,905,610 Light emitting device comprising a lightguide film
- 18) CA2702600 Light emitting devices and applications thereof
- 19) CA2702690 Light emitting devices and applications thereof
- 20) CA2702685 Light emitting devices and applications thereof
- 21) 8,794,812 Light emitting devices and applications thereof
- 22) 8,783,898 Light emitting devices and applications thereof
- 23) 8,761,565 Arcuate lightguide and light emitting device comprising the same
- 24) 8,721,152 Light emitting devices and applications thereof
- 25) 8,619,363 Light redirecting element comprising a forward diffracting region and a scattering region
- 26) 8,434,909 Light emitting display with light mixing within a film
- 27) 8,430,548 Enhanced light fixture with volumetric scattering
- 28) 8,408,775 Light recycling directional control element and light emitting device using the same
- 29) 8,249,408 Method of manufacturing an optical composite
- 30) 8,233,803 Versatile remote control device and system
- 31) 8,231,256 Light fixture comprising a multi-functional non-imaging optical component
- 32) 8,177,408 Light filtering directional control element and light fixture incorporating the same
- 33) 8,033,706 Lightguide comprising a low refractive index region
- 34) 8,033,674 Optical components and light emitting devices comprising asymmetric scattering domains
- 35) 7,991,257 Method of manufacturing an optical composite
- 36) 7,914,192 Enhanced light diffusing sheet
- 37) 7,784,954 Polarization sensitive light homogenizer
- 38) 7,758,227 Light fixture with curved light scattering region comprising ellipsoidal domains
- 39) 7,722,224 Illuminating device incorporating a high clarity scattering layer
- 40) 7,542,635 Dual illumination anisotropic light emitting device
- 41) 7,453,636 High contrast optical path corrected screen
- 42) 7,453,635 Imaging material with improved contrast
- 43) 7,431,489 Enhanced light fixture
- 44) 7,408,707 Multi-region light scattering element
- 45) 7,278,775 Enhanced LCD backlight
- 46) 7,015,893 Photoluminescent electrophoretic display

- 47) 6,861,788 Switchable display/mirror method and apparatus
- 48) 6,637,896 Compact projection system and associated device
- 49) 6,636,285 Reflective liquid crystal display with improved contrast
- 50) 6,151,142 Grazing incidence holograms and system and method for producing the same
- 51) 6,061,463 Holographic fingerprint device
- 52) 5,986,746 Topographical object detection system
- 53) 5,974,162 Device for forming and detecting fingerprint images with valley and ridge structure
- 54) 5,822,089 Grazing incidence holograms and system and method for producing the same
- 55) 5,710,645 Grazing incidence holograms and system and method for producing the same
- 56) EP0749610 Compact device for producing an image of the topological surface

US Patent Application Publications

- 1) 20180059690 Device with dynamic optical states using fluids with different optical properties
- 2) 20180059318 Film-based light fixture with light reflecting layer and fastener
- 3) 20180052274 Display with reflective spatial light modulator and a film-based lightguide frontlight folded behind the modulator to receive light from a light source positioned on an electrical display connector
- 4) 20170285243 Display including a guide element and film lightguide bent around the guide and behind the display
- 5) 20170235036 Light emitting device with a film-based lightguide comprising a light mixing region wrapped completely around coupling lightguides
- 6) 20170205572 Film-based light fixture with see-through light emitting region
- 7) 20170045669 Light emitting device comprising a film-based lightguide and reduced cladding layer at the input surface
- 8) 20150253487 Reflective display comprising a frontlight with extraction features and a light redirecting optical element
- 9) 20150219834 Display with a film-based lightguide and light redirecting optical element
- 10) 20150078035 Device comprising a film-based lightguide and component with angled teeth
- 11) 20140360578 Solar energy system including a lightguide film
- 12) 20140063853 Film-based lightguide including a wrapped stack of input couplers and light emitting device including the same
- 13) 20140056028 Light emitting device with adjustable light output profile
- 14) 20140049983 Light emitting device comprising a lightguide film and aligned coupling lightguides
- 15) 20130314942 Packaging comprising a lightguide
- 16) 20130250618 Light emitting device with light mixing within a film
- 17) 20130208508 Light emitting device with optical redundancy
- 18) 20130155723 Replaceable lightguide film display
- 19) 20120294620 Versatile remote control device and system
- 20) 20120288283 Versatile remote control device and system
- 21) 20120287674 Illumination device comprising oriented coupling lightguides
- 22) 20120082461 Versatile remote control device and system
- 23) 20110286222 Method of manufacturing an optical composite
- 24) 20110277361 Sign comprising a film-based lightguide
- 25) 20110273906 Front illumination device comprising a film-based lightguide
- 26) 20110255303 Illumination device comprising a film-based lightguide
- 27) 20110227487 Light emitting display with light mixing within a film
- 28) 20110013420 Light emitting devices and applications thereof
- 29) 20100321953 Light emitting devices and applications thereof
- 30) 20100321952 Light emitting devices and applications thereof
- 31) 20080094854 Dual illumination anisotropic light emitting device
- 32) 20080043490 Enhanced Light Guide
- 33) 20070201246 Enhanced Light Diffusing Sheet
- 34) 20060290253 Enhanced Diffusing Plates, Films and Backlights
- 35) 20060227546 Enhanced light fixture
- 36) 20060215958 Enhanced electroluminescent sign
- 37) 20060066945 High contrast optical path corrected screen
- 38) 20060056166 Enhanced LCD backlight
- 39) 20060056022 Imaging material with improved contrast
- 40) 20060056021 Multi-region light scattering element
- 41) 20050259302 Holographic light panels and flat panel display systems and method and apparatus for making same
- 42) 20040245902 Switchable display/mirror method and apparatus
- 43) 20040151491 Apparatus and method concerning a passive multi-indicia visual position indicator

- 44) 20040150613 Photoluminescent electrophoretic display
- 45) 20030081184 Compact projection system and associated device
- 46) 20030081154 Reflective liquid crystal display with improved contrast
- 47) 20030020975 Holographic light panels and flat panel display systems and method and apparatus for making same
- 48) 20020001110 Holographic light panels and flat panel display systems and method and apparatus for making same

International Patent Application Publications

- 1) **KR20180008882** Front illumination device comprising a film-based lightguide
- 2) **JP2013525955** Illumination device comprising a film-based lightguide
- 3) **JP2013525836** Sign comprising a film-based lightguide
- 4) **JP2013530412** Front illumination device comprising a film-based lightguide
- 5) **AU2012225244** Light emitting device with adjustable light output profile
- 6) **CA2829388** Light emitting device with adjustable light output profile
- 7) **EP2683980** Light emitting device with adjustable light output profile
- 8) **KR20130096155** Illumination device comprising a film-based lightguide
- 9) **MX2012012033** Illumination device comprising a film-based lightguide
- 10) **MX2012012035** Sign comprising a film-based lightguide
- 11) **MX2012012034** Front illumination device comprising a film-based lightguide
- 12) **CN103038568** Front illumination device comprising a film-based lightguide
- 13) **CN103038567** Illumination device comprising a film-based lightguide
- 14) **WO2012158460** Solar energy system including a lightguide film
- 15) **KR20130096155** Illumination device comprising a film-based lightguide
- 16) **KR20130055598** Front illumination device comprising a film-based lightguide
- 17) **KR20130054263** Sign comprising a film-based lightguide
- 18) **EP2558775** Illumination device comprising a film-based lightguide
- 19) **EP2558893** Sign comprising a film-based lightguide
- 20) **EP2558776** Front illumination device comprising a film-based lightguide
- 21) **CN102918435** Sign comprising a film-based lightguide
- 22) **GB2492398** Manufacturing an optical composite using inverted light collimating surface features
- 23) **WO2012122511** Light emitting device with adjustable light output profile
- 24) **WO2012088315** Packaging comprising a lightguide
- 25) **WO2012068543** Light emitting device comprising a lightguide film and aligned coupling lightguides
- 26) **WO2012044972** Versatile remote control device, system, and method
- 27) **WO2012016047** Light emitting device with optical redundancy
- 28) **CA2796515** Sign comprising a film-based lightguide
- 29) **CA2796518** Illumination device comprising a film-based lightguide
- 30) **CA2796519** Illumination device comprising a film-based lightguide
- 31) **WO2011130715** Illumination device comprising a film-based lightguide
- 32) **WO2011130718** Front illumination device comprising a film-based lightguide
- 33) **WO2011130720** Sign comprising a film-based lightguide
- 34) **CA2702600** Light emitting devices and applications thereof
- 35) **CA2702685** Light emitting devices and applications thereof
- 36) **CA2702690** Light emitting devices and applications thereof
- 37) **WO2007002317** Enhanced diffusing plates, films and backlights
- 38) **WO2006055872** Enhanced light fixture
- 39) **WO2006055873** Enhanced electroluminescent sign
- 40) **WO2006032002** High contrast optical path corrected screen
- 41) **WO2006026743** Enhanced light diffusing sheet
- 42) **WO2006031545** Enhanced LCD backlight
- 43) **WO2006020583** Imaging material with improved contrast
- 44) **WO2006017585** Multi-region light scattering element
- 45) **CN1573448** Switchable display/mirror method and apparatus
- 46) **KR20040104427** Switchable display/mirror method and apparatus including switchable mirror with display operation mode and mirror operation mode
- 47) **WO2003038509** Reflective liquid crystal display with improved contrast
- 48) **WO2003038517** Compact projection system and associated device

- 49) **AT195189** Device for forming and detecting fingerprint images with valley and ridge structure
- 50) **JPH09509490** Device for forming and detecting fingerprint images with valley and ridge structure
- 51) **AU1925595** Method of producing and detecting high-contrast images of the surface topography of objects and a compact system for carrying out the same
- 52) **CA2183567** Method of producing and detecting high-contrast images of the surface topography of objects and a compact system for carrying out the same
- 53) **WO199522804** Method of producing and detecting high-contrast images of the surface topography of objects and a compact system for carrying out the same

Publications and Presentations

- 1) "LED Technology," LED Lighting Panel Discussion at Heartland Angel's "LEDs: What are they and why are they important" Chicago, IL, (2010)
- 2) "Challenges and opportunities for light management optics in LED lighting systems," LEDs 2008 Conference, San Diego, CA, (2008)
- 3) "Optically efficient displays and solid-state lighting systems using anisotropic polymer films," SID, New England Chapter, Dec. (2006)
- 4) "Novel high brightness LED backlight design and optimization," Mark Chu, Zane Coleman, Kurt Henrickson, Terry Yeo, Americas Display Engineering and Applications Conference, Atlanta, GA (2006)
- 5) "Head-mounted displays for visual communication," Zane Coleman, George Valliath, Motorola Hermes, internal conference (2000)
- 6) "LCD glare avoidance using a surface relief diffractive optical element," Zane Coleman, George Valliath, Motorola Publication via www.IP.com
- 7) "Display optical enhancement films," Zane Coleman, George Valliath, Robert Akins, Kevin Jelley" Motorola Hermes, internal conference (1999)
- 8) "Design of hologram for brightness enhancement in color LCDs," G.T. Valliath, Z.A. Coleman, J.L. Schindler, R. Polak, R.B. Akins, K.W. Jelley, Society for Information Display '98, Conference Proceedings Vol. 29, p. 1139, Anaheim, CA (1998)
- 9) "Modern holographic recording and analysis techniques applied to edge-lit holograms and their applications," Ph.D. in Physics Thesis, Loughborough University, Loughborough, England (1997)
- 10) "Holographic optical element for compact fingerprint imaging system", M.H. Metz, N. J. Phillips, Z. A. Coleman, C. Flatow, Optical Security and Counterfeit Deterrence Techniques, SPIE Proceedings vol. 2660, San Jose, CA (1996)
- 11) "Holograms in the extreme edge illumination geometry", Zane A. Coleman, Michael H. Metz, Nicholas J. Phillips, Holographic Materials II, SPIE Proceedings vol. 2688, San Jose, CA (1996)
- 12) "The use of edge-lit holograms for compact fingerprint capture", M. Metz, C. Flatow, Z. Coleman, N.J. Phillips, CardTec SecureTec, April 10th, (1995)
- 13) "Links between holography and lithography," Phillips, Nicholas J.; Barnett, Christopher A.; Wang, Ce; Coleman, Zane A., Proc. SPIE Vol. 2333, p. 206-214, Fifth International Symposium on Display Holography, Tung H. Jeong; Ed. (1995)
- 14) "Dichromated gelatin--some heretical comments", N.J. Phillips, R. D. Rallison, C. A. Barnett, S. R. Schicker, Z. A. Coleman, Practical Holography VII:Imaging Materials, SPIE vol. 1914, pp 101-114 (1993)
- 15) "Novel methods for the creation of silver-free images in holography, using conventional silver halide emulsion", N.J. Phillips, Z.A. Coleman, C. Wang, Holographic Systems, Components, and Applications, IEE Conf. Publication No 379, Neuchatel, Switzerland (1993)
- 16) "Holograms in the edge-illuminated geometry-new materials developments", N.J. Phillips, C. Wang, Z. Coleman, Practical Holography VII:Imaging Materials, SPIE vol. 1914, pp 75-81 (1993)

Legal Consulting

Type of Matter:	Expert in Optics and Lighting for Plaintiff
Client:	Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name:	ITC Inv. No. 337-TA-1081 Philips Lighting N.A. v. Feit Electric Co. Inc., Satco Products, Inc., Topaz Lighting Corp., Wangs Alliance Corp (WAC Lighting), WAC Lighting(Shanghai) Co. Ltd., Lowe's Companies, L G Sourcing, MSi Lighting, Inc., RAB Lighting Inc.
Services:	Consulting
Date:	March 2017 – May 2018, completed
Type of Matter:	Expert in Optics and Lighting for IPR Petitioners
Client:	Schiff Hardin LLP
Case Name:	IPR2017-01287, IPR2017-01285, IPR2017-01280, Technical Consumer Products, Inc., Nicor Inc., Amax Lighting, Inc. Petitioning Lighting Science Group Corporation
Services:	Declarations for 3 IPR Petitions, Deposition, Consulting
Date:	March 2017 – Present
Type of Matter:	Expert in Optics and Lighting for Plaintiff
Client:	McKool Smith, P.C.
Case Name:	Ultravision Technologies, LLC v. Lamar Advertising Company (2:16-cv-374-JRG-RSP)
Services:	Two declarations, Product analysis, Work toward expert report
Date:	April 2016 – July 2017
Type of Matter:	Expert in Optics for Defendant
Client:	Foley and Lardner LLP
Case Name:	USPTO Patent Interference 105,972, Morgan Solar Inc. v Banyan Energy.
Services:	Two declarations, Support, Two-day deposition
Date:	March 2104 – September 2015
Type of Matter:	Expert in Optics for Plaintiff
Client:	Fried, Frank, Harris, Shriver & Jacobson
Case Name:	IPR2015-01044, Mercedes-Benz v. IDT LLC
Services:	One Declaration
Date:	April 2015 – June 2015
Type of Matter:	Expert in Optics for Plaintiff
Client:	Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name:	IPR2015-00831, Toyota Motor Corp. v IDT LLC
Services:	One Declaration, Consulting
Date:	May 2014 – May 2015
Type of Matter:	Expert in Optics for Plaintiff
Client:	Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name:	IPR2015-00832, Toyota Motor Corp. v IDT LLC

Services:	One Declaration, Consulting
Date:	May 2014 – May 2015
Type of Matter:	Expert in Optics for Plaintiff
Client:	Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name:	IPR2015-00834, Toyota Motor Corp. v IDT LLC
Services:	One Declaration, Consulting
Date:	May 2014 – May 2015
Type of Matter:	Expert in Optics for Plaintiff
Client:	Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name:	IPR2015-00835, Toyota Motor Corp. v IDT LLC
Services:	One Declaration, Consulting
Date:	May 2014 – May 2015
Type of Matter:	Expert in Optics for Plaintiff
Client:	Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name:	IPR2015-00843, Toyota Motor Corp. v IDT LLC
Services:	One Declaration, Consulting
Date:	May 2014 – May 2015
Type of Matter:	Expert in Optics for Plaintiff
Client:	Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name:	IPR2015-00855, Toyota Motor Corp. v IDT LLC
Services:	One Declaration, Consulting
Date:	May 2014 – May 2015
Type of Matter:	Expert in Optics for Plaintiff
Client:	Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name:	IPR2015-00857, Toyota Motor Corp. v IDT LLC
Services:	One Declaration, Consulting
Date:	May 2014 – May 2015
Type of Matter:	Expert in Optics for Plaintiff
Client:	Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name:	IPR2015-00897, Toyota Motor Corp. v IDT LLC
Services:	One Declaration, Consulting
Date:	May 2014 – May 2015
Type of Matter:	Expert in Optics for Defendant
Client:	Steptoe & Johnson LLP
Case Name:	ITC 337-TA-805, ITRI v. LG Corp.
Services:	Non-testifying consulting
Date:	Dec. 2011 – May 2013