

RESUME

Philip J. Bos

Personal Data

Home Address: 6806 Windsor Road
Hudson, Ohio

Telephone: (216)-655-7658

Birthdate: November 6, 1950

Education

Ph.D. Physics Kent State University May, 1978
(Deuterium Magnetic Resonance Studies of Orientational Order in the
Liquid Crystalline Phases)

M.A. Physics Kent State University Sept., 1974

B.A. Physics Hope College June, 1973

Employment

1997-present Associate Director (applied programs); Liquid Crystal
Institute, Kent State University

1995- present Associate Professor, Chemical Physics Program
Liquid Crystal Institute, Kent State University

7/95 - 9/95 Interim Director, Liquid Crystal Institute

1994-1995 Senior Research Fellow, Liquid Crystal Institute
Kent State University

1984-1993 Principal Scientist, Display Research Dept.
Tektronix Laboratories, Tektronix Inc.

1981-1984 Senior Scientist, Display Research Dept.
Tektronix Laboratories, Tektronix Inc.

1979-1981	Scientist, Display Research Dept. Tektronix Laboratories, Tektronix Inc.
1978-1979	Postdoctoral Fellow, Liquid Crystal Institute, Kent State University

Areas of Interest and Contributions

Graduate Education

Developed new graduate level course *Liquid Crystal Displays*, focusing on the science of liquid crystal device design. Established active research laboratory whose alumni have all found jobs in the field of liquid crystals.

Professional Education

Chair and co-developer of an ALCOM/KSU continuing education short course. *Liquid Crystals: Materials and Display Devices*, a multi-day lecture/lab course for professionals in the area of applications of liquid crystals has had over 150 participants from large domestic electronics, display and liquid crystal companies; universities; and several government agencies. Related to interest in the area of professional education, have given invited seminars or talks at several International Display Research Conferences as well as the Gordon Conference, Optical Society of America Annual Meeting, European Liquid Crystal Conference, International Liquid Crystal Conference, and several Society for Information Display International Symposiums. Active in conferences related to applications of liquid crystals; Program chair of the 17th International Display Research Conference; General Chair of the 20th International Display Research Conference.

Alignment Methods for SmC* Electro-optical Devices

Showed that a high tilt surface boundary condition could yield defect free SmC* electro-optic devices and true surface stabilized director configurations. Also showed importance of surface topography with low tilt surface boundary conditions on defect formation.

Director Field Transitions in Cholesteric Materials

Students (Watson and Anderson) showed how transition proceeds from field aligned homeotropic texture transforms to the transient planar and then to the equilibrium planar or the focal conic texture.

Finite Difference Time Domain (FDTD) Modeling

Student (Chuck Titus) showed how the FDTD method can be applied to problems in liquid crystals with off-axis light illumination. Provided the

first highly accurate descriptions of diffractive liquid crystal beam steering devices.

High Speed Liquid Crystal Electro-optical Effects

Considered importance of the coupling of flow and director reorientation in speeding the relaxation of the director field in nematic devices. Invented pi-cell device that has been used for commercially successful applications in the area of field sequential color and stereoscopic viewing systems .

Off-Axis Light Propagation for Nematic Electro-Optical Effects

Clarified importance of the symmetry of the director configuration when designing electro-optical effects with wide angle of view and invented an optically self compensating director configuration. This work has been used by myself in the OCB device that is being considered by many major LCD manufactures for next generation displays. Also showed application of negative birefringence films to several devices and designed practical “four-domain” alignment techniques.

Application of Polymer Stabilized Materials

Demonstrated that polymer stabilized materials could be used to improve performance of micro-lenses as well as STN and Bistable devices characterized as having the director in the center of the device nearly parallel or perpendicular to the cell normal. Have shown what may be first experimental evidence for reorientation of a polymer network as the surrounding liquid crystal director field is reoriented by an electric field.

Bistable Nematic and Cholesteric Electro-optical Effects

Have shown how polymer stabilized materials can allow a practical design of bistable devices characterized as having the director in the center of the device nearly parallel or perpendicular to the cell normal. For another type of device, bistable twist cells, demonstrated 100microsecond line times and have explored factors affecting the zero-field director configurations.

Diffractive and Beam Steering Devices

Invented polarization independent electro-optical diffraction grating based on optical activity rather than optical path length difference. Resulted in ability to demonstrate low voltage, high performance liquid crystal electro-optical effect for transmissive projection devices.

Industry / University Relations

Participated in proposals to obtain \$2.3 Million from the Ohio Board of Regents and nearly \$3 Million in equipment donations for a LCD research facility. Instigated interaction that brought the first new LCD company to North-Eastern Ohio that had no previous Ohio connections. Currently Director of the Industrial Partnership Program for the Advanced Liquid Crystal Optical Materials (ALCOM) NSF Science and Technology Center and Associate Director for applied programs of the Liquid Crystal Institute and oversee the positions of the IPP industrial liaison, and the LCD prototyping personnel.

Educational Activities

Course Development and Teaching

Developed Graduate level course “Liquid Crystal Displays” . Course has been offered annually since 1995.

Co-developed continuing education course “Liquid Crystals: Materials and Display Devices”. Course has been offered annually since about 1993

Undergraduates:

James Anderson, (Summer'95, Investigated use of polymer stabilization to make thick tunable birefringence devices for beam deflection)

Graduate Students:

Chad Hoke	1995-1999	Ph.D.	(to Hewlett Packard Laboratories)
Assad Kahn	1995-1995	M.S	(to Kent Display Systems)
Jim Anderson	1995 –		(to Hana Microdisplays Inc.)
Philip Watson	1996- 2000	Ph.D	(to 3M Optical Devices Div)
Hiroyuki Mori	1996-1999	Ph.D	(to Fuji Photo Film)
Chuck Titus	1997-		
Mike Alimov	1998-1999	M.S	(to S-Vision)
Shuxin Li	1998-1999	M.S.	(to Densitron)
Salman Saeed	1998-		
Bin Wang	1999-		
Erica Bramley	2000-		
Chenhui Wang	2000-		

Post Docs:

Mark Flynn	1994	(to Kaiser Electronics)
Dave Fredley	1994 - 1995	(to Motorola)
Jon Ruth	1994 -	
Jianlin Li	1995-1996	(to Polytronix)
Jianmin Chen	1995-1996	(to Samsung)
Jianfung Li	1996-1997	(to Reveo)
Ray Folks	1995-1996	
Vasa Sergan	1996 -	

Visiting Scientists

Janez Pirs	annually	(Inst. of Joseph Stephan, Slovenia)
H. Wilderbeek	1999	(Eindhoven University of Technology)
D.L.Seekola	1999	(University of Pretoria)
Prof. H. Okada	3/96 - 8/96	(Toyama Univ)
Prof. T. Nose	3/96 - 8/96	(Akita Univ)
N-D Kim	9/95 - 8/96	(Samsung)
Hiroyuki Mori	9/96 – 9/99	(Fugi-Film)
Jianmin Chen	1997	(Samsung)
J.J. Lyu	1997	(Samsung)

Professional Society Activities

Member Scientific Committee, 19th International Liquid Crystal Conference, Edinburgh (2002)

General Chair: 20th International Display Research Conference, Palm Beach Florida (2000)

Oversees Advisor, 6th International Display Workshop, Sendai Japan (1999); and 7th International Display Workshop, Kobe Japan (2000)

Member Scientific Committee, and session chair: 18th International Liquid Crystal Conference, Sendai Japan (2000)

Member program committee for the Society for Information Display annual conference. and session chairman 1993? – 2000

Session chair 19th International Display Research Conference, Berlin Germany (1999)

Oversees Advisor and session chair; 5th International Display Workshop, Kobe, Japan (1998)

Session chair at 1998 International Liquid Crystal Conference Ferroelectric Devices Session

Program Chair for 1997 International Display Research Conference, Toronto

Liquid Crystal Technology sub-committee chair , 1996 SID International Symposium.

NSF Engineering Research Center Site review team for Opto-electronic Computing Systems Center at Univ. of Colorado (Feb 15, 1996)

Session co-chair , 1996 International Displays Research Conference (Euro-display). Birmingham.

Session co- Chair at the Workshop on Advanced Liquid Crystal Display (at Asia Display'85) Hamamatsu Oct 19,1995.

Program Committee member and Session chair at the 1994 International Display Research Conference, Monterey.

Member, Society for Information Display Academic Committee.

Member Editorial board of *Liquid Crystals*

Book Chapters

The Effect of Polymer Networks on Twisted Nematic and SuperTwisted Nematic Displays . chapter by P.J.Bos, D. Fredley, J. Li, J. Rahman, Book edited by G. Crawford, Title of Book: Liquid Crystals in Complex Geometries Formed by Polymer and Porous Networks. Publisher : Taylor and Francis

Liquid Crystal Shutter Systems for Time-Multiplexed stereoscopic Displays in Stereo Computer Graphics and Other True 3D Technologies , Princeton Univ Press

Improvement of the Viewing Angle for Display Devices with Gray Scale, P. J. Bos, chapter in Liquid Crystals in the Nineties and Beyond Ed Satyendra Kumar, publisher: World Scientific Publishing. c 1995

Refereed Publications

Journal Articles:

"Study of Relaxations in Cholesteric Liquid Crystals after Reduction of an Electric Field" J.E. Anderson, P. Watson, P. J. Bos Accepted by Liquid Crystals.

"Twist-Energy Driven Helfrich Modulations in Cholesteric Liquid Crystals Illustrated in the Transient Planar to Planar Transition," P. Watson, J. E. Anderson, P. J. Bos, Accepted by *Phys. Rev. E*.

"Computer Simulation of the Homeotropic to Planar Transition in Cholesteric Liquid Crystals," P. Watson, J.E. Anderson, V. Sergan, P.J. Bos, Accepted by *Liq. Cryst.*

"Methods and Concerns of Compensating In-plane Switching LCD's," J.E. Anderson and P.J. Bos, Accepted by *Jpn. J. Appl. Phys.*

"Comparisons of the Vector Method and Tensor Method for Simulating Liquid Crystal Devices," J.E. Anderson, P. Watson, P.J. Bos, Accepted, *Liq. Cryst.*

"A Multi-dimensional Alignment for the Liquid Crystal Director Field," C.D. Hoke, P.J. Bos, accepted for publication, *J. Appl. Phys.*

"Polarized infrared study of a polymer network deformation in a nematic liquid crystal host," C. D. Hoke, J. F. Li, Y. H. Lin, L. C. Chien, P. J. Bos, S. Hudson, J. L. Koenig, *Liq. Cryst.*, **27** 359-363 (Mar., 2000).

"Computer simulation evidence of the transient planar state during the homeotropic to focal conic transition in cholesteric liquid crystals," J. E. Anderson, P. Watson, T. Ernst, P. J. Bos, *Phys. Rev. E*, **2000** 3951-3960 (Apr., 2000).

"Mechanism of Relaxation from Electric Field Induced Homeotropic to Planar Texture in Cholesteric Liquid Crystals," V. Sergan, Y. Reznikov, J. Anderson, P. Watson, J. Ruth, P. Bos, *Mol. Cryst. Liq. Cryst.*, **330** 1339 (1999).

The transition mechanism of the transient planar to planar director configuration change in cholesteric liquid crystal displays," P. Watson, J. E. Anderson, V. Sergan, P.J. Bos, *Liq. Cryst.*, **26** 1307-1314 (Sept., 1999).

"Modulated structures with electric field controlled direction and periodicity in SmC* liquid crystals," D. Subacius, D. Voloschenko, P. Bos and O.D. Lavrentovich, *Liq. Cryst.* 26, 295-298 (1999).

"Optical compensation of liquid crystal materials using negative birefringence compensation films," C.D. Hoke, H. Mori and P.J. Bos, *Jpn. J. Appl. Phys.* 38, L642-L645 (1999).

"Optical performance of the pi cell compensated with a negative birefringence films and an a-plate," H. Mori and P.J. Bos, *Jpn. J. Appl. Phys.* 38, 2837-2844 (1999).

"Characteristic times in the homeotropic to planar transition in cholesteric liquid crystals," P. Watson, V. Sergan, J.E. Anderson, J. Ruth and P.J. Bos, *Liq. Cryst.* 26, 731-736 (1999).

"Comparison of analytical calculations to finite-difference time-domain simulations of one-dimensional spatially varying anisotropic liquid crystal structures," C.M. Titus, P.J. Bos, J.R. Kelly and E.C. Gartland, Jr., *Jpn. J. Appl. Phys.* 38, 1488-1494 (1999).

"Multidimensional director modeling using the Q tensor representation," H. Mori, E.C. Gartland, Jr., J.R. Kelly and P. Bos, *Jpn. J. Appl. Phys.* 38, 135-146 (1999).

"Possibility of stereoscopic displays by using a viewing angle dependence of twisted nematic liquid crystal cells," H. Okada, J.M. Chen and P.J. Bos, *IEEE Trans. On Electron Devices* 48, 1445-1452. 1998

Patterned alignment, liquid crystal diffractive spatial light modulators & devices, C.E. Holton, P. Bos, M. Miller and W.E. Glenn, *Proc. SPIE* 3292 (1998).

In-plane liquid crystal beam steering devices with a beam separation structure, H. Okada, P.J. Bos and H. Onnagawa, *Jpn. J. Appl. Phys.* 37, 2576-2580 (1998).

Effect of Surface Topography on Defect Formation in Surface Stabilized Ferroelectric Devices, P. Watson, P. Bos, J. Pirs, *Phys.Rev. E.* 56, R3769-R3771 (1997).

Efficient, polarization-independent, reflective liquid crystal phase grating, C.M. Titus and P.J. Bos, *Appl. Phys. Lett.* 71, 2239-2241 (1997).

Cholesteric gratings with field-controlled period, D. Subaciu, S.V. Shiyonovskii, P. Bos and O.D. Lavrentovich, *Appl. Phys. Lett.* 71, 3323-3325 (1997).

A simple multi-mode stereoscopic liquid crystal display, J. Chen, K.H. Kim, N.D. Kim, J.H. Souk, P.J. Bos and S.T. Shin, *Jpn. J. Appl. Phys.* 36, L1685-L1688 (1997).

Switchable diffractive cholesteric gratings D.Subacius, P.J. Bos, O.D. Lavrentovich, *Appl. Phys. Lett.*, **71** 1350-1372 (1997)

The effect of material parameters on the hysteresis of bistable STN displays. J.Li, C.D.Hoke, P.J.Bos *Mol.Cryst.Liq.Cryst.* **304** p113 (1997)

The investigation of domain instability in the four domain twisted nematic configurations. J.Chen, J.Li, C.D.Hoke, D.L. Johnson, P.J.Bos *Mol.Cryst.Liq.Cryst.* **302** p151 (1997)

The effect of polymer networks on the electro-distortional characteristics of nematic liquid crystals. J.Li, J. Anderson, C.D.Hoke, Toshiaki Nose, P.J.Bos *Mol.Cryst.Liq.Cryst.* **301** p261 (1997)

Effect of Low polymer content in a liquid crystal microlens. T. Nose, S. Masuda, S. Sato, J. Li, L-C Chien, P. Bos *Optics Letters* 22 p351 (1997)

High efficiency light valve projectors and high efficiency laser light sources. W.E. Glenn, C.E.Holton, G.J. Dixon, P.J. Bos *SMPTE Journal* 106, No.4 p210 (1997)

The high-field cured polymer networks in nematic liquid crystals, J. Li, J.E. Anderson, C.D. Hoke, T. Nose and P.J. Bos, *Jpn. J. Appl. Phys.* 35 L1342 (1996)

High-speed addressing of a 0-360 bistable twisted nematic liquid crystal display, C.D. Hoke, J. Li, J.R. Kelly and P. J. Bos, *Jpn. J. Appl. Phys.* 36 L227 (1996)

Super-twisted nematic LCDs with multi-domain structures, J. Li, E.S. Lee, H. Vithana and P.J. Bos, *Jpn. J. Appl. Phys.* 35 (1996) ppL1446

Four-domain twisted nematic liquid crystal display fabricated by reverse rubbing polyimide process, J. Chen, P.J. Bos, D.L. Johnson, D.R. Bryant, S.H. Jamal and J.R. Kelly, *Journal of Applied Physics*, Vol. 80, No. 4, p1985 1996,.

A model of liquid crystal alignment by exposure to linearly polarized ultraviolet light, J. Chen, D.L. Johnson, P.J. Bos, X. Wang and J.L. West, *Physical Review E*, Vol. 54, No. 2, p1599 (1996).

Polymer stabilized STN devices,” D.S. Fredley, J. Li, B. Quinn and P.J. Bos, *J. of SID*, **4**, No. 2 p89 (1996).

Radially and azimuthally oriented liquid crystal alignment patterns fabricated by linearly polarized ultraviolet exposure process, J. Chen, P.J. Bos, S. Sprunt and D.L. Johnson, *Appl. Phys. Lett.*, 68, 885(1996).

Optimization of luminance for optical-mode-interference (OMI) displays, J. Li, J.R. Kelly, C. Hoke and P.J. Bos, *J. of SID*, 4, No. 2 p95 (1996).

Studies of bistability of highly twisted nematics, J. Li, C.D. Hoke and P.J. Bos, *Jpn. J. Appl. Phys.*, 35 L706(1996).

Nearly Homeotropic Aligned Four-Domain Liquid Crystal Display with Wide Viewing Angle. H. Vithana, D. Johnson, P. Bos, R. Herke, Y. Fung, S. Jamal, *Jpn. J. Appl. Phys.* Vol 35 (1996) p 2222

Controlled Tilted Homeotropic Alignment of Liquid Crystals For Display Applications. H. Vithana, D. Johnson, P. Bos . *Jpn. J. Appl. Phys.* Vol 35 (1996) ppL320

Four Domain Twisted Nematic Liquid Crystal Display Fabricated by Two Alignment Layers with Low and High Pretilt Angles. Jianmin Chen, Philip J. Bos, David L. Johnson, Jack R. Kelly, Nam-Deog Kim, John Crow. *Japanese Journal of Applied Physics Part 2, Letters*, Vol. 35 No 5A, ppL558 (1996).

An optically active diffractive (OAD) device for a high efficiency diffractive light valve," P.J. Bos, J. Chen, J.W. Doane, B. Smith, C. Holton and W. Glenn, *Journal of the SID*, 3/4, 195(1995).

Simple Four-Domain Twisted Nematic Liquid Crystal Display , J. Chen, P.J. Bos, D.R. Bryant, D.L. Johnson, S. H. Jamal, J.R. Kelly . *Appl. Phys Lett*, 67 (14) 2 October 1995 p1990

An Electro-Optically Controlled Liquid Crystal Diffraction Grating, J. Chen, P.J. Bos, H. Vithana, D.L. Johnson. *Appl. Phys. Lett.* 67 (18) p2588 1995 (R)

Contrast and Color Uniformity Optimization of an LCD Pi Cell Pixel, M. Flynn, and P. Bos , *Mol. Cryst. Liq. Cryst.* 1995 Vol. 263 p377-387

Dynamic Drive for Bistable Reflective Cholesteric Displays : A Rapid Addressing Scheme *Journal of the SID*, 3/4, 165 (1995), X.-Y. Huang, D. -K. Yang, P. J. Bos, J. W. Doane. (R)

Time Sequential StereoScopic Displays: The Contribution of Phosphor Persistence to the "Ghost" Image Intensity, P.J. Bos *The Journal of Three Dimensional Images* Vol 8 No1 p 69-72 (1994)

Field-Sequential Stereoscopic Viewing Systems Using Passive Glasses Proc. of SID **30/1** 39 (1989) P. J. Bos, T. Haven (J)

A Method for Director Alignment of SmC* Devices *Ferroelectrics*, **85**, p15 (1988) P.J.Bos, K.R. Koehler / Beran (R)

A Full-Color Field Sequential Color Display *Proc. of the SID*, **26** p157 (1985) P. Bos, T. Buzak, R. Vatne (J)

The • -cell, A Fast Liquid-Crystal Optical Switching Device. *Mol. Cryst. Liq. Cryst.* **113** p329 (1984) P.J. Bos, K.R.Koehler/Beran (R)

New LC/CRT Field Sequential Color Display R.S. Vatne, P.A.Johnson, P.J.Bos Proc. SID **25** p31 (1984)

Optical Bounce Removal and Turn-Off Time Reduction in Twisted Nematic Displays *IEEE ED-28*, **6**, p723 (1981) R. Hubbard, P. Bos (R)

Removal of the Optical Bounce and Turn-off Time Reduction in Twisted Nematic Displays R. L. Hubbard, and P.J. Bos. Proc. of the SID **22** No.4 p297 (1981)

Direct NMR Observation of Rotational Freeze-Out in the Smectic-C Phase *Phys. Rev. A* **23** 6 p3346 (1981), D. J. Photinos, P. J. Bos, M. E. Neubert, and J. W. Doane. (R)

Liquid Crystals as Observed by NMR *Ferroelectrics*, **24** p203 (1980), J. W. Doane, P. J. Bos, N. A. Vaz, and A. Shetty.(R)

Molecular and Relative Segmental Order in Nematic and Smectic C Phases: A Nuclear Magnetic Resonance Study *J. Chem Phys.* **73**(2) p733 (1980), P. Bos, A. Shetty, J.W. Doane, and M. E. Neubert. (R)

NMR Measurement of Biaxial Molecular Order in the Smectic-C Phase *Phys. Rev. A* **20**(5), p 2203 (1979), D. J. Photinos, P. J. Bos, J. W. Doane, and M. E. Neubert. (R)

NMR in Spinning Samples of Biaxial Liquid Crystals *Phys. Rev. Lett.* **B42**(15) p996 (1979), P. J. collings, D. J. Photinos, P. J. Bos, P. Ukleja, and J. W. Doane. (R)

Molecular Order versus Conformational Change in the Liquid Crystal Phases *Phys. Rev. Lett* **40**(15) p1030 (1978), P. J. Bos, and J. W. Doane. (R)

Molecular Orientational Order and NMR in the Uniaxial and Biaxial Phases
Mol. Cryst. Liq. Cryst. **40** p59 (1977), P. J. Bos, J. Pirs, P. Ukleja, J. W. Doane,
and M. E. Neubert (R)

Conference Articles:

"A method of generating full color LCD using birefringent filters in a stacked design," S. Saeed, P. J. Bos and Z. Li, *SID Digest XXXI*, 830-833 (2000).

"Two crossed A-plates as an alternative to a negative C-plate," V. Sergan, P. J. Bos, and G. D. Sharp, *SID Digest XXXI*, 838-841 (2000).

"Significant speed and stability increases in multi-dimensional director simulations," J.E. Anderson, C. Titus, P. Watson and, P.J. Bos, *SID Digest XXXI*, 906-909 (2000).

"Lyotropic thin film polarizers," Y. Bobrov, C. Cobb, P. Lazarev, P.J. Bos, D. Bryant and H. Wonderly, *SID Digest XXXI*, 1102-1105 (2000).

"Status and Trends in Nematic Bistable Liquid Crystal Displays," P.J. Bos, P. Watson, J.E. Anderson, V. Sergan, C.D. Hoke, Proceedings of The 19th International Display Research Conference, p 397 (1999), **Invited**

"Effects of pretilt angle on electro-optical properties of Pi-cell LCDs," X.-D. Mi, M. Xu, D.-K. Yang and P.J. Bos, *SID Digest XXX*, 24-27 (1999).

"Shortcomings of the Q tensor method for modeling liquid-crystal devices," J.E. Anderson, P. Watson and P.J. Bos, *SID Digest XXX*, 198-201 (1999).

"Two-dimensional optical simulation tool for use in microdisplay analysis," C.M. Titus, P.J. Bos and J.R. Kelly, *SID Digest XXX*, 624-627 (1999).

"Three-dimensional modeling of ridge-fringe-field LCDs," J.E. Anderson, P.J. Bos, C. Cai and A. Lien, *SID Digest XXX*, 628-631 (1999).

"The investigation of undertwist defect near the threshold in STN-LCDs," S. Li and P.J. Bos, *SID Digest XXX*, 640-643 (1999).

"Optimization of bend cells for field-sequential-color microdisplay applications," P. Watson, P.J. Bos, J. Gandhi, Y. Ji and M. Stefanov, *SID Digest XXX*, 994-997 (1999).

"Long time scale relaxation of the homeotropic to planar transition of short pitch cholesteric materials," P. Watson, V. Sergan, J. Anderson, J. Ruth and P.J.

Bos, *Proc. of the 18th International Display Research Conference*, pp. 291-294 (1998). **Invited**

"Reflective CMOS liquid crystal display design considerations," Y. Ji, M.E. Stefanov, W.R. Folks and P.J. Bos, *Proc. of the 18th International Display Research Conference*, pp. 419-422 (1998).

"Amorphous silicon thin-film transistor active-matrix reflective cholesteric liquid crystal display," J.Y. Nahm, T. Goda, B.H. Min, T.K. Chou, J. Kanicki, X.Y. Huang, N. Miller, V. Sergan, P. Bos and J.W. Doane, *Proc. of the 18th International Display Research Conference*, pp. 979-982 (1998).

Cholesteric Diffraction Devices with a Field-Controlled Grating Vector
S.V. Shiyonovskii, D. Subacius, D. Voloschenko, P.J. Bos, O.D. Lavrentovich
Proceedings of the SPIE'98 San Diego Calif

"Defects in the π cell with striped electrodes," H. Mori, E.C. Gartland, Jr., J.R. Kelly and P.J. Bos, *Proc. 5th Intl. Display Workshop*, pp. 77-80 (1998).

"Modeling of polymer stabilized liquid crystals," C.D. Hoke, F. Xu and P.J. Bos, *Proc. 5th Intl. Display Workshop*, pp. 101-104 (1998).

"A multi-dimensional alignment (MDA) structure and its application for the stabilization of the bistable twist cell," C.D. Hoke and P.J. Bos, *Proc. 5th Intl. Display Workshop*, pp. 201-204 (1998). **Invited**

"Poincare sphere analysis on the optic Proc. Asia Display 98, pp. 419-422 (1998). al behavior of a discotic negative birefringence film," H. Mori and P.J. Bos, *Proc. 5th Intl. Display Workshop*, pp. 243-246 (1998).

Very high pretilt alignment and its application in Pi-cell LCDs, M. Xu, D.K. Yang, P.J. Bos, X. Jin, F.W. Harris and S.Z.D. Cheng, *SID 98 Digest XXIX*, 139-142 (1998).

Optimum film compensation modes for TN and VA LCDs, J. Chen, K.H. Kim, J.J. Jyu, J.H. Souk, J.R. Kelly and P.J. Bos, *SID 98 Digest XXIX*, 315-318 (1998).

A fast frame-rate bistable cholesteric reflective display, J. Anderson, P. Watson, J. Ruth, V. Sergan and P.J. Bos, *SID 98 Digest XXIX*, 806-809 (1998).

Designing concepts of the discotic negative birefringence compensation films, H. Mori and P.J. Bos, *SID 98 Digest XXIX*, 830-833 (1998).

A bistable twist cell exhibiting long-term bistability suitable for page-sized displays,C.D. Hoke and P.J. Bos, *SID 98 Digest XXIX*, 854-857 (1998).

A study of the dynamics of reflection color, helical axis orientation, and domain size in cholesteric LCDs, P. Watson, V. Sergan, J.E. Anderson, J. Ruth and P.J. Bos, *SID 98 Digest XXIX*, 905-908 (1998).

Application of a Negative Birefringence Film to Various LCD Modes H.Mori, P.J.Bos *IDRC* , **17** M88 (1997) Invited

An Ultra Wide Viewing Angle STN-LCD with a Negative Birefringence Compensation Film C.D.Hoke, H.Mori, P.J.Bos *IDRC* , **17** p21(1997)

Reflective Liquid Crystal Displays J. Ruth, R. Hewitt, P. Bos *Digest of the Flat Panel Display Strategic Forum and Technical Symposium*. Invited

The Effect of Material Constants on the Long Term Stability of the Bistable Twist Cell. C.D.Hoke, P.J.Bos *IDRC* **17**, p85 (1997)

Electric field effects and defects in layered liquid crystals, O.D. Lavrentovich, D. Subacius, P.J. Bos and S.V. Shiyonovskii, *Proc. Fourth Intl Display Workshop*, pp. 29-32 (1997).

Matrix Addressing of a 0-360 degree Bistable Twist Cell C.D. Hoke, J.R. Kelly, J Li, P.J.Bos, *Society for Information Display Digest of Technical Papers* **28**, p29 (1997)

Brightness Optimization of D-STN LCDs Using the Traveling Wave Compensator. J.E.Anderson, J.Li, P.J Bos, R.G Culter, K.F. Kongslie, A.Gard *Society for Information Display Digest of Technical Papers* **28**, p671 (1997)

Effects of Surface Topography on Formation of Zig-Zag Defects in SSFLC Devices. P. Watson, P.J.Bos, J.Pirs, *Society for Information Display Digest of Technical Papers* **28**, p743 (1997)

Efficient Polarization-Independent Reflective Liquid Crystal Phase Gratings. C.M.Titus, P.J.Bos, C.Holton, W.Glenn *Society for Information Display Digest of Technical Papers* **28**, p769 (1997)

Optical Simulation of Electro-Optical Performance of Low Delta-nd Multi-domain TN Displays. J.Chen, P.J.Bos, J.R.Kelly, N.D.Kim, S.T.Shin *Society for Information Display Digest of Technical Papers* **28**, p937 (1997)

A Four-Domain Twisted-Nematic Display Stabilized by Polymer Networks J. Li, J. Chen, P. J. Bos, *IDRC* **16** p 460 (1996)

Four-domain TN-LCD fabricated by two alignment layers with low and high pretilt angle, J. Chen, P.J. Bos, D.L. Johnson, J.R. Kelly, N.D. Kim and J. Crow, Society for Information Display Digest of Technical Papers **28**, p650 (1997)

Confirmation on mechanism of liquid crystal alignment by exposure to linearly polarized ultraviolet light, J. Chen, D.L. Johnson, X. Wang and J. L. West, Society for Information Display Digest of Technical Papers **27**, p634 (1996)

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Optically Active Diffractive Device
P.J. Bos, B. Smith, C. Holton, W. Glenn

<u>Country</u>	<u>Patent Number</u>	<u>Issue Date</u>
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Low Electro-Optic Threshold Liquid Crystal Cell and Method of Fabricating Same
P.J. Bos, J. A. Rahman

<u>Country</u>	<u>Patent Number</u>	<u>Issue Date</u>
United States	5,606,442	02/25/1997
China	pending	
European Pat Con	pending	
Japan	pending	
South Korea	pending	
Taiwan	pending	

Color Liquid Crystal Display Having a Wide Angle of Viewing Angle
P.J. Bos

<u>Country</u>	<u>Patent Number</u>	<u>Issue Date</u>
United States	5,550,662	08/27/1996

Gray Scale LC Device Having a Wide Viewing Angle

P.J. Bos

<u>Country</u>	<u>Patent Number</u>	<u>Issue Date</u>
United States	5,410,422	04/25/1995
China	pending	
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Switchable Color Filter and Field Sequential Full Color Display System

P. J. Bos, P. A. Johnson Jr.

<u>Country</u>	<u>Patent Number</u>	<u>Issue Date</u>
United States	5,387,920	02/07/1995
Germany	DE 3486342	08/31/1994
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High Contrast Light Shutter System

P.J. Bos

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Japan	pending	

Liquid Crystal Fiber Optic Attenuator

S. H. Rumbaugh, M. D. Jones, , F. Scheu, P. J. Bos

<u>Country</u>	<u>Patent Number</u>	<u>Issue Date</u>
United States	5,015,057	05/14/1991

Polarization Controller for Use in Optical Fiber Communications

S. H. Rumbaugh, M.D. Jones, P.J. Bos

<u>Country</u>	<u>Patent Number</u>	<u>Issue Date</u>
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Chiral Liquid Crystal Cell

P. J. Bos

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Drive Waveform For Ferroelectric Displays

P. J. Bos

<u>Country</u>	<u>Patent Number</u>	<u>Issue Date</u>
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Stereoscopic Imaging System with Passive Viewing Apparatus

P.J. Bos

<u>Country</u>	<u>Patent Number</u>	<u>Issue Date</u>
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Germany	3607629	11/16/1989
United Kingdom	2175171	04/25/1986
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Japan	2032155	03/19/1996

Method and Apparatus for Reducing Optical Cross Talk in a Liquid Crystal Optical Switch

P.J. Bos, D. W. Prince

<u>Country</u>	<u>Patent Number</u>	<u>Issue Date</u>
United States	4,652,087	03/24/1987

High Speed Electro-Optical Light Gate and Field Sequential Full Color Display System Incorporating Same

P. J. Bos

<u>Country</u>	<u>Patent Number</u>	<u>Issue Date</u>
United States	4,635,051	01/01/1987
Germany	3485365.0	12/18/1991
Germany	DE3486422	02/28/1996
France	0138455	12/18/1991
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Netherlands	0138455	12/18/1991

Netherlands **0422687** **02/28/1996**

Field Sequential Color Display System

P.J. Bos, P.A. Johnson Jr.

<u>Country</u>	<u>Patent Number</u>	<u>Issue Date</u>
United States	4,582,396	04/15/1986
Canada	1219692	03/24/1987
Germany	3416518.5	05/04/1984
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France	2545961	05/09/1984
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United Kingdom	2184860	02/10/1988
Japan	2074595	07/25/1996
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Netherlands	Pending	

Rapid Starting High-Speed Liquid Crystal Variable Optical Retarder

P.J. Bos

<u>Country</u>	<u>Patent Number</u>	<u>Issue Date</u>
United States	4,566,758	

Patent Pending

A Bistable LCD using Polymer Stabilization

J. Li, P.J. Bos