40 Years of SID Symposia – Nurturing Progress in Liquid Crystal (LC) Technology

1960's

Image Generation

- **1964** Guest-Host mode **RCA**
- **1969** Helfrich has TN idea **RCA**
- **1964** Dynamic Scattering Mode **RCA**

LC Materials

- **1969** MBBA apolar Schiff base **Hoechst**
- **1967** **RCA** develops room temp. apolar Schiff base mixtures

Manufacturing milestones

Passive-addressing milestones

- **RCA** developes CMOS technology

Product milestones

1970's

Image Generation

- **1970** Schadt & Helfrich start collaboration on field effects at **Roche** and file Swiss TN patent
- **1970** Fergason independently conceives TN and files US TN patent later bought by Roche
- **1972** Raynes eliminates reverse domains in TN
- **1974** **White-Taylor** cholesteric guest-host display **Bell Labs**
- **1974** Berremann uses 4x4 matrix to model TN configurations **Bell Labs**
- **1973** 1st and 2nd TN minimum understood Gooch & Tarry

LC Materials

- **1970** Demus apolar esters
- **1970** Room temp azoxy compounds **Hoechst**
- **1971-1973** First commercial alkyl cyano Schiff base and cyano ester TN mixtures **Roche**
- **1972** Gray, Harrsion, Nash biphenyls **BDH**
- **1973** Demus alkyl-alkoxy cyclohexane esters
- **1976** 1.5 volt pyrimidine TN mixtures **Roche**
- **1976** Cyano-phenyl cyclohexanes **Merck**

Manufacturing milestones

- Alignment by oblique evaporation
- Hermetic frit + solder package
- Polymide brushing alignment material
- Batch processing
- Distributed glass fiber spacers
- Ion barrier layer on soda lime glass

Passive-addressing milestones

- **1973-1974** Kawakami and Alt-Pleshko independently develop optimized MUX drive
- **1979** Nehring & Kmetz publish "Ultimate limits for matrix addressing"

Product milestones

- **1973** **Sharp** EL-805 pocket calculator using DSM
- **1973** **Brown Boveri** makes first commercial TN displays (Casio watches)

1980's

Image Generation

- **1982** Waters and Raynes Super-twisted guest-host mode **RSRE**
- **1981** Berreman-Heffner 360 bistable cell **Bell Labs**
- **1983** **Brown Boveri** develops STN Displays display
- **1987** **Seiko-Epson** develops DSTN
- **1988** Stretched retarder film compensated STN **Sharp & Seiko-Epson**

LC Materials

- **1980s** Alkenyl LCs enabling large STN mux ratios ad short TFT response **Roche**
- **1980s** Fluorinated, TFT-TN compatible LCs **Merck, Chisso**

Manufacturing milestones

- **1987** Nitto Denko makes mechanically stretched optical retarder films
- "Touch polished" flat glass

Passive-addressing milestones

- **1988** Ruckmongathan publishes IHAT technique

Product milestones

- **1983** Monochrome TN panel used in Data General portable computer
- **1988** Monochrome STN panel for computer notebooks

1990's

Image Generation

- **1991** Yang demostrates multidomain TN **IBM**
- **1992** Baur et al present IPS mode; 1995 **Hitachi** presents IPS display
- **1993** Cholestric bistable reflective display **KSU/KDI**
- **1993** Myata et al propose OCB mode
- Single-polarizer reflective modes for low power and LCOS
- **1996** 199x prototype Zenithal Bistable Display **MOD**

LC Materials

- **1990** Diffusro substituted materials with negative dielectric anisotropy **Merck**

Manufacturing milestones

- Pixellated color filters for color displays
- **1995** **Fuji** develops discotic wide view film for TFT-TN displays
- **1995** **3M** introduces BEF & DBEF multi-layer brightness enhancement films

Passive-addressing milestones

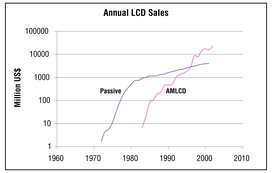
- **1991** MLA/MLS addressing independently **InFocus/Asahi Glass**
- **1990** "Frame response" found by **Citizen Watch Co.**

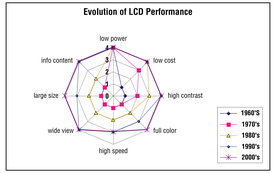
Product milestones

- **1992** "Dual scan" color STN panels (notebook computers)
- **1990** Stacked STN panels used in subtractive color mode LCD projector color
- **1993** **Kent Display Ind.** commercializes ChLCDs

2000's

- **2001** **Nemoptic** develops BiNem display
- **2002** CSTN cell phone displays with single-chip MLS drivers introduced
- **2003** BiNem displays for e-book products





SID Award Recipients for Liquid Crystal (LC) Technology

Jan Rajchman Prize
- Terry J. Scheffer
- William Doane
- Shunsuke Kobayashi

Karl Ferdinand Braun Prize
- George W. Gray
- Martin Schadt

Frances Rice Darne Memorial Award
- James L. Fergason

SID Fellows
- Paul M. Alt
- Günter Baur
- Dwight W. Berreman
- Philip J. Bos
- William Doane
- James L. Fergason
- Cornelius J. Gerritsma
- Werner E. Haas
- Frederic J. Kahn
- Eiji Kaneko
- Hideaki Kawakami
- Allen R. Kmetz
- Shunsuke Kobayashi
- Shochi Matsumoto
- Koichi Miyaji
- Shohei Naemura
- P. Andrew Penz
- Peter Pleshko
- E. Peter Raynes
- Martin Schadt
- Terry J. Scheffer
- Lawrence Tannas, Jr.
- Tatsuo Uchida
- Tomio Wada
- Shin-Tson Wu
- Kei-Hsing Yang

Special Recognition
- Paul M. Alt
- Birendra Bahadur
- Dwight W. Berreman
- Joseph A. Castellano
- Noel A. Clark
- C. J. Gerritsma
- George H. Heilmeier
- Eiji Kaneko
- Rudolph Kiefer
- Katsumi Kondo
- Karel Kuijk
- Sven T. Lagerwall
- Shohei Naemura
- Jurgen Nehring
- E. Peter Raynes
- Martin Schadt
- Terry J. Scheffer
- Bernhard Scheuble
- Tatsuo Uchida
- Georg Weber
- Shin-Tson Wu