50 Years of SID Symposia – Nurturing Progress in AMLCD Technology

1960's

AMLCD Products

1962
First Liquid Crystal "Light Valve" & Patent
RCA

1968
First Active Matrix Liquid Crystal Display ("AMLCD")
RCA

Active Matrix Technology

AMLCD Image Quality

AMLCD Electronics

1970's

AMLCD Products

1972
First AMLCD prototype using CdSe TFTs
Westinghouse

1972
First AMLCD patent
Westinghouse

1978
First AMLCD Projection Light Valve
Hughes

Active Matrix Technology

1970
First CdSe Thin Film Transistor "TFT"
Westinghouse

1978
First amorphous-silicon aSi TFT
University of Dundee, RCA

1975
Liquid-Crystal-on-Silicon LCoS TFT
Hughes

1980's

AMLCD Products

1983
5V aSi AMLCD TV
Seiko Epson

1984
5V pSi AMLCD TV
Matsushita

1988
8V Avionic Display
GE

1988
10V AMLCD Laptop
Mitsubishi

1986
pSi Projection Light Valve
Seiko Epson

Active Matrix Technology

1981
MIM diode LCDs
Seiko Epson, OIS, Philips

1988
Low-Resistance Wiring
Toshiba

AMLCD Image Quality

1980
Passive-Matrix LCD with 20° viewing angle, Contrast Ratio 2:1

1983
Active-Matrix increases CR to 20:1

1988
Black-Matrix increases CR to 100:1

AMLCD Electronics

1984
Analog data drivers
Seiko Epson

1984
Line and dot inversion hide flicker
Seiko Epson, Philips, GE

1990's

AMLCD Products

1995
15V Computer Monitor
Hoshiden

1992-1993
Commercial expansion of projection TFT LCDs
Seiko Epson, Sharp

1995
Time-Multiplexed 3D AMLCD
Cambridge University

Active Matrix Technology

1992
Crystalline-Si Projection AMLCDs
Kopin, Sarnoff

1998
First pentacene organic TFTs
Pennsylvania State University

1995
First aSi AMLCD with Integrated Scanners
Sarnoff, Thomson GP

AMLCD Image Quality

1995
In Plane Switching for improved viewing angle
Hitachi

1998
Vertical Alignment improves viewing angle, CR
Fujitsu

1996
Planarized ITO improves angle, brightness, CR
Sharp, NEC, OIS

1996
Retardation films improve viewing angle
Fuji, OIS

AMLCD Electronics

1992
6 bit data drivers

1997
High-speed analog display interfaces
Silicon Image, National Semi

1998
8 bit digital data drivers
Vivid Semiconductor

1992
Overdrive reduces motion blur
Toshiba, Honeywell

2000-2012

AMLCD Products

2002
42V TV
LG, Sharp, Samsung

2004
57V TV
Samsung, LG

2006
108V TV
Sharp

2001
High-Resolution AMLCDs
IBM

2002
Flexible AMLCDs
Sony, Sharp

2007
120 Hz TV
Sharp, Samsung

2001
Low-Power AM-Electrophoretic Displays
E-Ink, IBM, Lucent, Princeton

Active Matrix Technology

2006
First ZnO TFT Display
Kochi University, Casio

2000
Simplified 5-mask aSi Process
Samsung, LG, AUO

AMLCD Image Quality

2003
CR ≥ 1,000:1
Chi-Mei Optoelectronics

2005
Local Dimming Improves CR ≥ 100,000:1
Univ of Electro-Com Tokyo

2000
Patterned Vertical Alignment for improved viewing angle and contrast
Samsung

2002
LED backlit AMLCD
Advanced Display Inc.

2005
Multi-Primary AMLCDs expand color gamut
Philips, Samsung

2000
170° viewing angle
Fujitsu, Sharp, Philips, LG

AMLCD Electronics

2000
Digital display interfaces (DVI, HDMI)
TI, Silicon Image

2002
10 bit data drivers
Sharp

AM Technology SID Award Winners

Jan Raichman Prize
- Peter LeComber 1994
- Webster Howard 2003
- Hideo Hosono 2009

Karl Ferdinand Braun Prize
- Peter Brody 1987
- Jun Suok 2012

Frances Rice Darne Mem. Award
- Bernard Lechner 1971

Slottow-Owaki Prize
- Ernst Lueder 2009

Fellows
- Bernard Lechner 1970
- Peter Brody 1983
- Webster Howard 1983
- Zvi Yaniv 1989
- Setsuo Kanako 1990
- Masami Yoshiyama 1991
- Fang-Chen Luo 1992
- Hiroo Hori 1995
- Chizuka Tani 1996
- Alan Knapp 1996
- Günter Bauer 1997
- Fumiaki Funada 1998
- Ernst Lueder 1998
- Shinji Morozumi 1998
- Shoichi Matsumoto 1999
- Hiroyuki Ohshima 2000
- Takeo Sugiura 2001
- Nebuki Ibaraki 2003
- Alan Lien 2003
- I-Wei Wu 2003
- Kouji Suzuki 2004
- Willem Den Boer 2006
- Jin Jang 2006
- Kalluri Sarma 2007
- John Zhong 2009
- Jun Souk 2009
- Min-Koo Han 2009
- Sang Soo Kim 2009
- Wei Chen 2010
- Haruhiko Okumura 2010
- Roger Stewart 2010
- In Jae Chung 2011
- Brian Berkeley 2012

Special recognition Award
- Peter Brody 1975
- Shinji Morozumi 1988
- Tatsuo Uchida 1988
- Fang-Chen Luo 1990
- Karel E. Kuijk 1992
- Shigeo Aoki 1994
- Masaya Hijkigawa 1995
- Tsunekiyo Iwakawa 1995
- Takeo Sugiura 1995
- Yasuhisa Oana 1995
- Thomas Buzak 1996
- Michel leContellec 1996
- Francois Morin 1998
- Katsumi Kondo 1998
- Rudolph Kiefer 1998
- John C.C. Fan 1999
- Yasuyuki Gotoh 1999
- Kenji Okamoto 1999
- Kouji Suzuki 1999
- Yasumasa Takeuchi 1999
- Malcolm Thompson 1999
- Nobuki Ibaraki 2000
- Taiishire Kurita 2002
- Yoshifumi Shimodaira 2002
- Jing Jang 2003
- Haruhiko Okumura 2004
- Hsuan-Bin Chen 2004
- Hideki Asada 2006
- Jun Souk 2006
- Joseph Jacobson 2006
- Hirofumi Wakemoto 2006
- John Rupp 2007
- In-Jae Chung 2007
- Peter Bocko 2009
- Hideo Hosono 2009
- Byung Chul Ahn 2009
- Lorne Whitehead 2010
- Helge Seetzen 2010
- Gregory Ward 2010
- Tieer Gu 2011
- Oh-Kyong Kwon 2011
- Shigeaki Mizushima 2012
- Masayuki Sugawara 2012
- John Wager 2012

Please Note . . .

This panel on the evolution of AMLCDs over the past 47 years is a sampling of what are perceived as TRULY SIGNIFICANT milestones that led to advancements which had major impact on commercialization of AMLCD technology.

The field of AMLCDs is very broad. The milestone chart shows the advances in technology and products along four strands: AMLCD Products that were commercial/industrial successes, Active Matrix Technology developments, improvements in AMLCD Image Quality, and significant developments in AMLCD Electronics.

Please note that for ease of interpretation the chart milestones regarding size (expressed in diagonal viewable area in inches), contrast ratio and viewing angle are aligned in distinct rows – the former in the AMLCD Products band (top, green), the latter two in the AMLCD Image Quality band (third from top, blue).

Progress in the technology of AMLCD relied on major contributions by many companies, institutions and individuals too numerous to mention. This chart cannot claim to be comprehensive in acknowledging all those contributions, but it does attempt to capture those advances that had both pervasive and significant impact for a substantial period of time on the display industry.

Contributors to initially generating (2003) and in 2010/12 revising this Milestone Technology Chart

2003 - **Willem den Boer (chair)**, Fang-Chen Luo, Ernst Lueder, Roger Stewart
2010/12 Revision – **Roger Stewart (chief architect)**