

Report on SID's symposium to commemorate 50 years of LCD research

On Thursday, June 7th 2018 at the Royal Academy of Engineering in London over 70 people participated in a one day symposium to commemorate 50 years of LCD research.

In May 1968, at their headquarters in the Rockefeller Building in New York, RCA announced the world's first Liquid Crystal Display, based on the work of George Heilmeyer and his team. This announcement stimulated researchers in Europe and Japan to instigate their own LCD research programmes, directly leading to the success of the LCD industry seen today. The symposium included speakers from those early pioneering years, as well as those currently researching the next generation of LCD and related display technologies.

Professor Cliff Jones from Leeds University and founder of ZBD Displays introduced the agenda for the day. Cliff was responsible for arranging the symposium and organising the speakers.

The following is a summary of the 11 talks given at the symposium:

1. Cyril Hilsum, CBE, FRS, FREng focused on the first 10 years of LCD activity from 1968. The Royal Radar Establishment (RRE), later known as The Royal Signals and Radar Establishment (RSRE), began an examination of flat panel display technologies including EL, flat CRT, LCD and electrophoretic in 1968. Cyril was Chief Scientist at RSRE in those early years and initiated and led the collaboration between RSRE, Hull University and BDH that resulted in the world's first stable room temperature liquid crystals. RSRE started serious work on flat radar display technology with MOD funding in 1978 under Cyril's leadership. This work and the work of other centres of excellence in the UK led to the development of stable materials at Hull University and amorphous silicon backplanes at Dundee University leading to the first prototype active matrix LCD in 1978. Cyril talked about the challenge of convincing Government to invest in an emerging technology, something that is still as relevant today for researchers.



Cyril Hilsum

2. Martin Schadt, inventor of the Twisted Nematic (TN) LCD, and fundamental contributor to photo alignment. Martin talked about the shift from dynamic scattering mode to field effect mode LCD and how this improved the optical and electronic performance of LCDs. In 1970, Martin Schadt and Wolfgang Helfrich invented the twisted nematic field effect (TN-effect) in the Central Research Laboratories of F. Hoffmann-La Roche Ltd, in Basel, Switzerland. This became the basis of the LCD industry. In 1973, the technology was licensed to Seiko on a non-exclusive basis and soon to other companies such as Sharp and Hitachi. This led to the development of more complex displays (by multiplexing) that over 4 decades, combined with numerous other innovations, has resulted in the modern flat panel display market.



Martin Schadt

3. Henning Sirringhaus, FRS from the University of Cambridge, pioneer of Organic TFT for display applications, and founder of Plastic Logic and Eight19. Henning's talk focused on the future, in particular organic TFT, flexible LCD developments and how the performance of organic semiconductors has improved dramatically in the past 20 years. FlexEnable, a leading Cambridge based company in the field has produced 12 inch organic TFT LCD prototypes and flexible LCD processing under 90 degrees C. New developments are looking at improved plastic substrates and integration of In Plane Switching (IPS) and Fringe Field Switching (FFS) modes.



Henning Sirringhaus

4. Paul Gass, Research Manager at Sharp Laboratories looked at the heritage of Sharp in the LCD sector- from pocket calculator to 8K TV in 45 years. Sharp started mass production of TN LCD in 1975 and in 1986 they developed optical compensation films for Super Twisted Nematic (STN) that led to colour passive displays. Sharp was the first company to invest in a G10 TFT line in 2009 with substrate size in excess of 3m by 3m. They also developed the wide viewing angle Vertical Alignment LCD and new developments include flexible and free form LCDs.



Paul Gass

5. Peter Raynes, FRS. Peter led many of the early inventions in LCD at RSRE, including wide temperature liquid crystals, defect free alignment of the TN and the STN LCD. By adding small amounts of chiral liquid crystals and pre-tilting the surface of the substrates it was found that many of the defects in TN LCD could be avoided. A liquid crystal mixture named E7 was developed from 4 component materials supplied by the University of Hull. E7 was widely licenced and supplied in collaboration with BDH (now Merck). The STN effect has a sharper on/off characteristic than TN enabling higher rates of multiplexing resulting in higher resolution panels. This technology was widely adopted by industry from the late 1980s and is still in production.



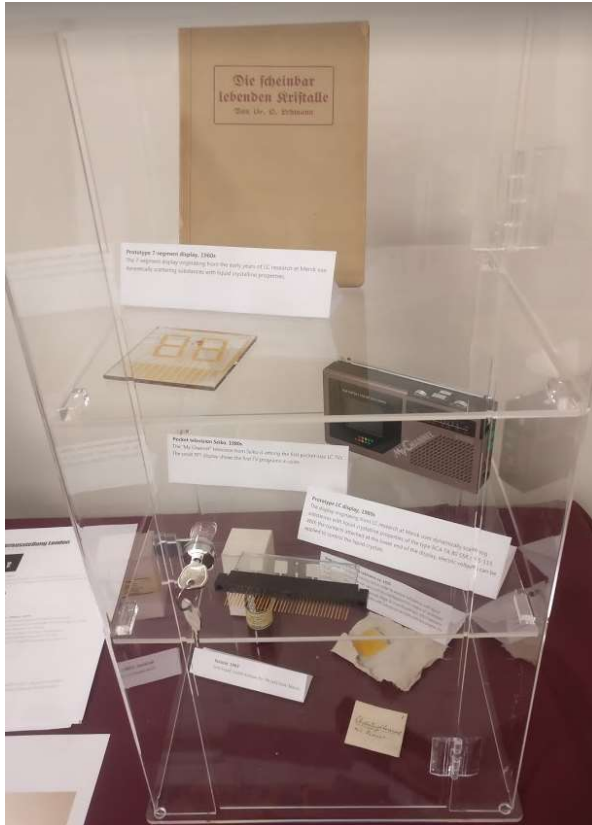
Peter Raynes

6. Phil Bos, Associate Director of the Liquid Crystal Institute at Kent State University, inventor of the pi-cell LCD and major contributor to non-display applications of liquid crystals, notably in the field of liquid crystal lenses and adaptive optics. Phil

had a positive observation about the role of RSRE in the history of the display market – he believes they made the LCD industry viable by developing stable materials, controlling defects, improving understanding and making the knowledge available to the world. Phil talked about his current innovations including liquid crystal contact lenses that could revolutionise the industry due to their tuneable power, small size, low cost, low power consumption, and high-speed switching.

7. John Rudin, Founder/CTO and COO at Folium Optics in Bristol talked about the company's work on reflective LCD in order to reduce power consumption and improve visibility in bright ambient conditions. Their technology is based on Guest/Host LCD – a nematic cell doped with suitable dyes. This eliminates the need for polarisers and results in wide viewing angle displays compatible with plastic processing. Potential markets include health tags, high visibility reflectors and camouflage applications.
8. Guy Bryan-Brown, Director of Technology at Displaydata Ltd talked about reflective displays in the shelf edge labelling area. There are numerous challenges, not least a 5 year battery life requirement on the unit including communications. Displaydata is technology agnostic and EPD is the currently preferred solution due to easier manufacturing and lower cost of active matrix backplanes. Since it started in 2000 as ZBD Displays, Displaydata has shipped 10 million display based price labels.
9. Mark Verral, Senior vice president of product development for the Display Solutions business unit of Merck talked about Merck's heritage in the liquid crystal sector. LC material was first offered as a curiosity material as far back as 1904! Now Merck is the leading LC material company worldwide with a market share of around 70%. The LC in a panel consists of a mixture of between 10 and 20 separate materials and Merck's research and close cooperation with key customers are viewed as critical to success. LCD is expected to continue to dominate the display market for the foreseeable future as new developments such as 8K TV, transparent displays, plastic, VR etc. emerge.
10. Philip Yuan, VP of BOE Technology Group, a company founded in 1993 in Beijing China, and one of the world's leading display makers, producing both LCDs and OLEDs. The focus of the talk was on future developments, in particular around active matrix OLED which has an annual growth rate of around 18% by volume. BOE is planning additional OLED capacity with Gen 4.5, 5.5 and three Gen 6 lines with 2,000+ employees by 2019. Innovations include the development of foldable products.
11. Peiman Hossein, founder and Chief Technology Officer of Bodle Technologies in Oxford. Bodle's innovative technology is centred on the creation and manipulation of colour reflected off a surface by changing the refractive index of ultra-thin functional layers. It is technically challenging but very high performance reflective colour displays with 50% reflectivity and 70% colour gamut can be achieved.

The symposium included an authentic look back at the past 50 years of LCD research with insights from some of the people that shaped the industry. It also looked at some emerging display trends and technologies that will shape the next 50 years.



A selection of exhibits from meeting sponsors (clockwise from top-left) Merck, BOE, and FlexEnable

The SID UK and Ireland chapter wishes to thank all the speakers and to Cliff Jones for organising the day. Also, many thanks to the sponsors, Merck, Displaydata, BOE, FlexEnable, Sharp, Institute of Physics and Folium Optics.