Displays • Network • Europe

advanced displays research integration action

Three days training seminars: outline of lectures

First day: displays based on phosphors excitation (CRT, PDP and FED (SED-CNT) panels).

Seeing displays, merits and shortcomings,

by Karlheinz BLANKENBACH, Pforzheim University

Evaluating display performance is not as simple as it seems at first sight. For example, not all parameters that are vital to the perception of the user can be measured in an easy and standardized way. This talk enables participants to understand how displays generate an image and how they are specified. Image generation can be reached in very different ways causing principally the same visual sensation. Therefore, the basics of the human visional system are introduced and related to display parameters like luminance, contrast, grey scale and colour.

Display performance has to be verified for both (quasi) static and dynamic characteristics following the path from input data to the displayed image. Static features are, e.g., electro-optic dependency, lifetime, Modulation Transfer Function, colour gamut, uniformity and viewing angle.

Display driving – described by following the path from data source via display controller to single pixels – is also affected by dynamic effects. Analogue bandwidth and digital signal processing limit the image quality regarding sharpness etc.; response time and motion blur are other important features here. Displaying video on Flat Panel Displays usually requires scaling, frame rate conversion and de-interlacing; therefore software algorithms substantially determine the video display quality. All this is essential to understand the ideas behind each display technology and their merits and shortcomings.

PDPs versus CRTs,

by Sebastien WEITBRUCH, Thomson Brandt

First of all the CRT technology, its basic assets, performances and drawbacks will be examined.

Next the PDP technology will be introduced, how does it work, its basic principles and related characteristics. We will comment on the

PDP electronics: Anatomy of a PDP. Evolution and major impacts. Current product definition and product roadmaps... and on the
PDP manufacturing: Current situation and prospects for the future: Is there any room for further cost down or new applications?
PDPs will be compared to CRTs, reviewing basic parameters and first assets.
Image quality of PDP, i.e. color behavior: color triangle and white point will be described.
And finally, PDP signal processing issues and artefacts will be reviewed, including:
- Grayscale rendition method and related motion artifacts, solution thereof
- European 50Hz issue: large area flicker and solution thereof
- Grayscale portrayal and related issues
- Power management
- Line-load effect and solarization
- Contrast
- Stereoscopic possibilities of the technology?

Future FED panels based on CNT electron sources,

by Vu Thien BINH, Université Lyon 1

The main points that will be presented are :

1. Recalls about the two basic mechanisms for extracting electron from a solid: thermionic ("hot cathodes") and field emission ("cold cathodes")
The highlights will be put on the order of magnitude of the values of the main parameters in order to identify the working conditions and how to tailor them for a given application.
2. Why carbon nanotubes (or in general nanocompounds) constitute presently a technological breakthrough for field emission displays ?
The two main key-points are the fabrication cost and the field emission current stability under bad vacuum conditions.
3. The state of art about the different CNT growth techniques.
The growth of isolated CNTs with defined diameter and location has been achieved with plasma enhanced chemical vapor deposition technique (PE-CVD) , so the fabrication of FE devices based on deterministic growth of isolated vertically aligned CNTs (va-CNTs) is now possible.
4. The state of art about the field emission characteristics of CNTs.
Stability and lifetime of the different CNT cathodes.
5. The different approaches using field emission for FED panels.
A comparative analysis between the present different solutions will be presented in order to replace the CNT solution in a general context and overview perspective.

Second day: displays using light source spatial modulation, direct view LCDs and micro displays

Direct-view LCDs,

by Jose MAGARINO, Thales Avionics LCD

The lecture will address the following points:

1) Transmissive displays: angle of view properties.
Properties of the twisted nematic cell at oblique angles, Fuji film compensation principle and limits of the compensation
2) New liquid crystal effects with improved angle of view.
in plane switching (IPS) and fringe field switching (FFS), multi domain vertically aligned effect (MVA), improvements of MVA and advanced super view effect (ASV), optically compensated bend mode (OCB)
3) Compensation of these modes.
IPS compensation, VA compensation, and OCB compensation
4) Transflective displays
Introduction of the transflective pixel, viewing angle compensation and new liquid crystal modes.
5) Response time will be introduced and defined.
the back flow effects: OCB mode advantages; IPS response time and MVA response time
6) Motion picture quality
Overdriving principle and examples, mechanism of motion blur image on AMLCD, motion picture response time (MPRT) definition

Micro-displays

by André VAN CALSTER, Ghent University

Liquid crystal on silicon (LCOS) is an emerging display technology yielding very high resolution displays at a cost–effective price setting. Large screen (>50” diagonal) HDTV applications are considered to be the driving force of the LCOS technology.
Sony and JVC are the leading LCOS brands being very successful in the rear projection TV business. However also non-vertical integrated LCOS companies are entering the display market, both in consumer displays (HDTV) and professional information displays.
Due to its capability of achieving very high resolutions (> qxga), LCOS becomes an attractive technology for simulation and e-cinema applications. LCOS imagers with a pixel count of more than 8 million pixels have been reported.
In this talk an overview will be given of the different microdisplay technologies. The leading vertical aligned nematic LCOS technology will be discussed in more detail, while in the last part of this talk the potential of the technology will be illustrated by a number of applications.

Active Matrix technologies

by Didier PRIBAT, CNRS/Ecole Polytechnique

Among Flat panel displays (FPDs), active matrix liquid crystal displays (AMLCDs) are certainly the most popular as they represent ~ 70% of the overall FPD revenue over the past few years. Although the AMLCD industry is now very mature, the thin film transistors (TFTs) that are used to switch the liquid crystal pixels suffer some severe drawbacks, such as poor transport properties and poor stability under permanent gate voltage solicitation. This is because hydrogenated amorphous silicon (a-Si:H) which is employed for TFT fabrication is a metastable material. In other words, TFTs made from a-Si:H are not adapted to the control of other electro-optic materials such as organic light emitters because the addressing scheme is different from LCDs and the duty cycle is close to unity at least for the drive transistor.

Indeed, organic light emitting diodes (OLEDs) are believed to be the next generation of active matrix display materials, because of advantages such as rapid, totally video-compatible response time, simpler display architecture (no backlight and no polarisers are needed), lower power consumption, etc…

As a consequence, huge research efforts are being made by display manufacturers in order to develop new transistor technologies for display addressing, amenable to the simplicity of that used for AMLCDs and able to perform the addressing of OLED materials. Materials such as microcrystalline and polycrystalline silicon have been studied for some time, but the former tends to yield TFTs with high leakage current and the latter seems to be confined to niche applications because the technology is complex and the productivity low. New comers in the field are semiconductor nanowires and they hold great promise.

On the other hand, since flexible displays are of great interest for portable products (rollable products in the future), research efforts are being devoted to active matrix fabrication on flexible substrates. Schematically, two different routes are studied, namely (i) direct TFT integration on plastic, which means decreasing processing temperatures while still keeping acceptable device characteristics (this holds for *e.g.*, amorphous and microcrystalline Si) and (ii), transfer techniques, where the TFT matrix is fabricated on a separate substrate (*e.g.*, glass) and subsequently transferred onto the plastic substrate.

As far as direct TFT integration is concerned, organic transistors (OTFTs) are considered serious contenders, since they can be fabricated at room temperature and mobility values higher than those of a-Si:H TFTs have been obtained. However, OTFT stability remains to be assessed as few studies have addressed this problem so far.

Third day: the organic route to low-cost & flexibility : OLED and large area "plastic" electronics.

Organic electroluminescent materials,

by Tom Mc LEAN, Merck Chemicals

In an introductory part, we will describe how electronic processes work in organic materials.

In a first part, we will review the materials that are used for OFETs and Plastic Electronics and their processing steps.
Semiconductors: small molecule OSCs, polymeric OSCs, interfaces and stability, lifetime issues, process and patterning issues
Dielectrics / Insulators: influence of dielectric on OSC performance, dielectric patterning and process issues
Conductors: conductor requirements, polymeric conductors, printable metals, metal Semiconductor Interfaces
Substrates: substrate requirements, substrates for plastic electronics.

In a second part, we will describe properties of materials for OLEDs
Light emitting Semiconductors, Small Molecules for OLEDs, Polymers for PLEDs, and Phosphorescent Molecules.
Conductors and Blockers, Hole injection layers and Blocking Layers
Barrier Materials and Multilayer Barriers.

Organic Light Emitting Displays and flexible displays,

by Christophe PRAT, Thomson

This seminar is an attempt at giving an overview of the OLED display technology.

At the end of the 80's, the OLED appeared as a revolutionary structure able to challenge to the liquid crystal in the field of the flat panel display. Two main groups of organic materials are currently available to make OLED structures, each of them having their specific ways to be deposited onto a backplane to make a display. These materials and techniques have performances, advantages and drawbacks making them more or less suitable for display mass manufacturing. The display itself can be of passive or active matrix type. For this latter type of display, a large variety of pixel circuitry has been developed in order to overcome the non-uniformities of the pixel luminance over the display area and the drift of the TFT performances in time.

One of the main assets of the OLED display, apart of their potential low manufacturing cost, is the low power consumption which depends mainly on the efficiency of the OLED structures of each color, red, green and blue and on the light that is finally extracted from the whole device.
All these points are evocated in the presentation and illustrated by up-to-date data and values

Electronics as an Enabling Technology for e-Paper Displays

by Seamus BURNS, Plasticlogic

The main points that will be addressed are the followings:

1) Flexible display applications and requirements:
Focus on e-paper applications: electronic shelf label (ESL), signage and e-readers as three key examples.
2) Review of display media for e-paper applications:
Review the main contemporary technologies such as LCD (bistable nematic and zenithal), electrophoretic (microencapsulated, microcups liquid powder..), rotating ball, electrochromic etc.
Highlight the requirement for a flexible AM backplane (not direct drive/segmented) to fulfil the high information content and fast update needs of an e-paper application.
3) Identify AM backplane requirements to drive bi-stable media in e-paper applications:
Review the main elements of backplane design, materials and process, and performance metrics.
4) Review of flexible active matrix backplane processes:
Approaches reported to date include the transfer of conventional glass silicon mask-based processes onto: ultra-thin glass, metal foil substrates, high glass transition temperature (Tg) plastic substrates etc.
Review the organic TFT processes developed e.g. patterned by mask alignment; patterned by printing etc.
5) The Plastic Logic Process for printing organic thin film transistor backplane arrays:
Highlight the key attributes of the Plastic Logic (PLL) approach and processing remit, and how it meets the requirements to drive bi-stable media in e-paper applications.
Discussion of the commercial viability: scalability, low capital expenditure and low materials costs etc.
6) The future of e-paper display technologies:
Evolution of EP display media: higher greyscale capability, route to colour, video rate, higher flexibility, lower voltage etc. Review the consequent performance requirements for the active matrix backplane.
Highlight the evolving/scientific breakthroughs in plastic electronic technologies and how they address future application needs.