Thursday March 9th

10h00 – 12h00 Registration at the conference center The Strip at the High Tech Campus Eindhoven

12h00 – 13h00 Lunch

13h00 Welcome
Opening by Dr. P.E. Wierenga
Senior Vice President Philips Research Europe - Eindhoven

13h15 Start session 1 “Electronic Paper”

13h15 – 13h35 “Development of 5.1-inch High Speed SVGA Bistable BiNem® LCD for Electronic Paper Applications”
Jacques Angelé, Nemoptic

13h35 – 13h55 “Experience the brighter world of visual DNA™”
Michael Ryan, Ntera

13h55 – 14h15 “Video-speed electronic paper based on electrowetting”
Rob Hayes, Liquavista

14h15 – 14h35 “A new generation of e-readers takes off”
Alex Henzen, Irex

14h35 – 14h55 “A Computer Simulation and material for Electrophoretic Displays”
Kimiya Takeshita, Mitsubishi Chemical

14h55 – 15h25 Coffee break

15h25 Start session 2 “3D Displays”

15h25 – 15h45 “Novel autostereoscopic displays with user interaction”
Klaus Hopf, Fraunhofer Institute for Telecommunications (HHI)

15h45 – 16h05 “Optimization of wavelength selective parallax barrier displays”
William Hopewell, NewSight Corporation

16h05 – 16h25 “Design of wide viewing freedom flat panel 2D/3D displays”
Paul May, Ocuity Limited

16h25 – 16h45 “Uniformity improvement through fractional view systems”
Oscar Willemsen, Philips Research Europe

16h45 – 17h05 “True 3D displaying with the Holovizio System”
Tibor Balogh, Holografika Kft.

17h05 Start session 3 “Student Award”

17h05 – 17h35 “Student award presentation”
Model for the properties and behaviour of electronic paper
Tom Bert, TFCG Microsystems – Elintec, Ghent University

17h35 Informal drinks

18h30 Dinner

Estimated time: 21h00

Busses to Eindhoven
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<tr>
<th>Time</th>
<th>Session</th>
<th>Speaker(s)</th>
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<tr>
<td>09h00</td>
<td>Start session 4 “Flexible Displays”</td>
<td>Nicholas Colaneri, Flexible Display Center, Arizona State University</td>
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<tr>
<td>9h00 – 9h20</td>
<td>“TFT Backplanes on Flexible Foils: A Status Report”</td>
<td>Nicholas Colaneri, Flexible Display Center, Arizona State University</td>
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<tr>
<td>9h20 – 9h40</td>
<td>“Inorganic LTPS TFTs on metal for flexible AM-OLED displays”</td>
<td>François Templier, CEA-LETI</td>
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<td>9h40 – 10h00</td>
<td>“Organic transistors and their application in active-matrix displays”</td>
<td>Gerwin Gelinck, Polymer Vision</td>
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<td>10h00 – 10h20</td>
<td>“Polymers behind the scenes: on how structured polymers enhance your displays”</td>
<td>Dirk J. Broer, Technical University Eindhoven, Dept. Polymer Technology (SKT)</td>
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<td>10h20 – 11h00</td>
<td>Coffee break (including 10h30 the SID-MEC General meeting)</td>
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<td>10h50</td>
<td>Start session 5 “Signal Processing”</td>
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<td>10h50 – 11h10</td>
<td>“The impact of new display technologies on HDTV broadcasting in Europe”</td>
<td>Richard Salmon, HDTV Systems Project</td>
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<td>11h10 – 11h30</td>
<td>“Mobile Display Signal Processing”</td>
<td>Petri Nenonen, Nokia Research Center</td>
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<td>11h30 – 11h50</td>
<td>“Design consideration of field sequential display”</td>
<td>Emo Langendijk, Philips Research Europe</td>
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<td>11h50 – 12h10</td>
<td>“Display System Architecture for LCD-TV”</td>
<td>Gerben Hekstra, Philips Research Europe</td>
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<td>12h10 – 12h30</td>
<td>“Precise measurement of the light emission temporal behaviour of flat panel displays”</td>
<td>Pierre Boher, Eldim</td>
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<td>12h30 – 13h30</td>
<td>Lunch</td>
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<td>13h30 – 14h00</td>
<td>Introduction MiPlaza and open innovation</td>
<td>Gerjan van de Walle and Hans Naus, High Tech Campus Eindhoven</td>
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<td>14h00 – 14h05</td>
<td>Announcements</td>
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<td>14h05 – 15h30</td>
<td>Visit MiPlaza, demonstrations and sponsor booths in sub-groups</td>
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<td>15h30 – 16h30</td>
<td>Visit to the OTB company: OLED manufacturing line near Eindhoven airport</td>
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Model for the properties and behavior of electronic paper

T. Bert, V. Degezelle, G. Van Steenberge, S. Van Put, P. Geerinck & H. De Smet

TFCG Microsystems – Elintec
Ghent University
### EPID Benefits and Drawbacks

**Benefits:**
- bistability
- lightweight
- readability
- flexibility

**Drawbacks:**
- switching speed
- no threshold
- no colour
- **electrochemical complexity**
Particles inside an EPID

Neutral pigment particles
$R = 0.4 \text{micron}$

Clear apolar solvent

Pigments:
optical response

Micelles:
electrical response and …

Surfactant molecules
$L \sim 10 \text{nm}$

Floculate to inverse micelles

Contrasting dye
EPID

Optical response & delay time
Current peak broadens, becomes lower, later and more pronounced.
- Optimization of switching speed is pure chemical and physical process
- Intelligent display design
- Investigation of other display materials

There is a need for better understanding of display properties and a means to model behavior
- Gaussian distribution: average value measures drift, standard deviation measures diffusion.
- one-dimensional simulation: pixel dimension parallel to the field is much smaller than perpendicular.

\[
n(x, t) = \frac{N}{\sqrt{2\pi} \nu_{\text{diffusion}} t} e^{-\frac{1}{2} \left(\frac{x-v_{\text{drift}} t}{\nu_{\text{diffusion}} t}\right)^2}
\]
From charged particle distribution:
transient currents, voltage dependence, …

\[ \nu(x,t,V_1,V_2) = \frac{dx}{dt} = \frac{\frac{dn(x,t,V_1,V_2)}{dt}}{\frac{dn(x,t,V_1,V_2)}{dx}} \]

\[ J(t,V_1,V_2) = \int_{0}^{d} \nu(x,t,V_1,V_2)n(x,t,V_1,V_2)dx \]
From pigment distribution: delay time, switching speed,…

\[
I(t,V_1,V_2) = I_0 s \int_0^t R(t_d) \left[ \int_0^d n(x,t-t_d,V_1,V_2) e^{-\alpha x} \, dx + \int_d^\infty n(x,t-t_d,V_1,V_2) \, dx \right] \, dt_d
\]
\[ \varepsilon_0 \varepsilon_r \nabla E = \varepsilon_0 \varepsilon_r \frac{dE}{dx} = \rho(x) = n(x)e \]

\[ \Delta E(t) \approx \frac{NQ}{\varepsilon} \frac{1}{\sqrt{2D}} \frac{1}{\left( t + \frac{Q \, c_{st}}{8\pi \varepsilon D V_1} \right)^{1/2}} \]

Reduce charge to increase field strength: centrifugation
$R(t_d) = \frac{1}{\sqrt{2\pi \sigma_{\text{delay}}}} e^{-\frac{1}{2} \left(\frac{(t_d - T_{\text{delay}})^2}{\sigma_{\text{delay}}^2}\right)}$

$T_{\text{delay}} = \frac{\Delta s}{\mu} \frac{V_2}{d} - \frac{1}{N} \sqrt{4\pi Q \over \varepsilon \ast \text{cst}} \sqrt{V_1}$
Link between model parameters (diffusion velocity, drift velocity,...) and real parameters (viscosity, temperature, charge, pigment radius,...)
Results

Dependence on applied voltage

![Graph showing current dependence on applied voltage](image)

- 0.5V from -10V
- 2V from -10V
- 10V from -10V
Results

Dependence on previous voltage

![Graph showing the dependence of current on previous voltage.](image-url)
Results

Optical response
Results

Temperature dependence

\[ \eta \approx \exp \left( \frac{E_1}{kT} \right) \]

\[ \nu \approx \frac{T}{\exp \left( \frac{E_1}{kT} \right)} = T \exp \left( -\frac{E_1}{kT} \right) \]

\[ N \approx \exp \left( -\frac{E_2}{kT} \right) \]

\[ \text{delay} \approx \frac{\exp \left( \frac{E_1}{kT} \right) \exp \left( -\frac{E_2}{kT} \right)}{T} = \frac{\exp \left( -\frac{E_2 - E_1}{kT} \right)}{T} \]
Conclusion

Electrical & Optical simulation of EPIDs
Physical, measurable parameters are used
Importance of field screening and centrifugation

→ Optimize displays production