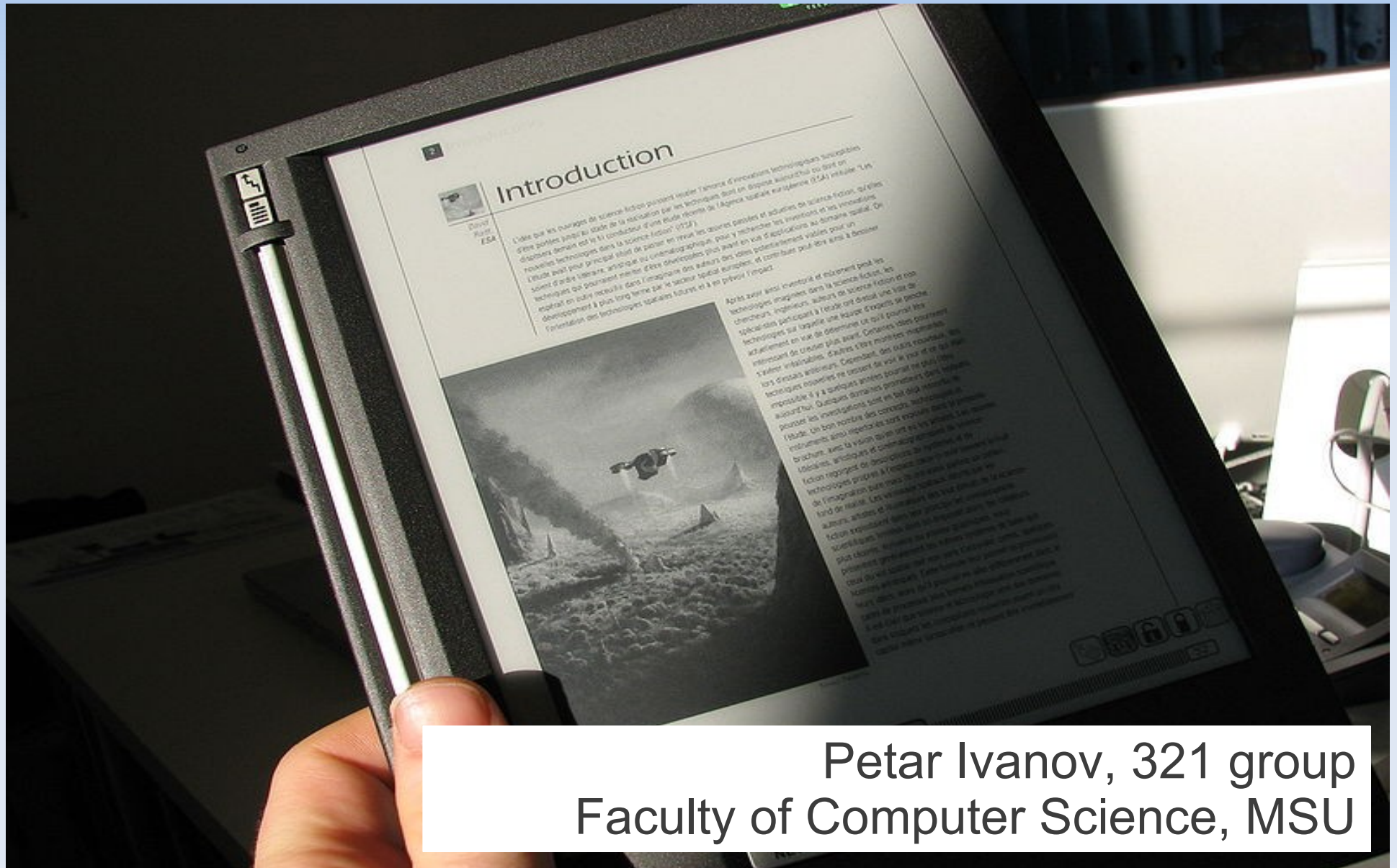


Electronic paper (e-paper, electronic ink)



Petar Ivanov, 321 group
Faculty of Computer Science, MSU

- Properties: almost as contrast as a display



Reads like real paper — no glare, even in bright sunlight



Properties: flexible



Properties: full-color soon



Properties: cheap and thin

- \$79.00 for a Kindle Wi-Fi with 6" E Ink Display



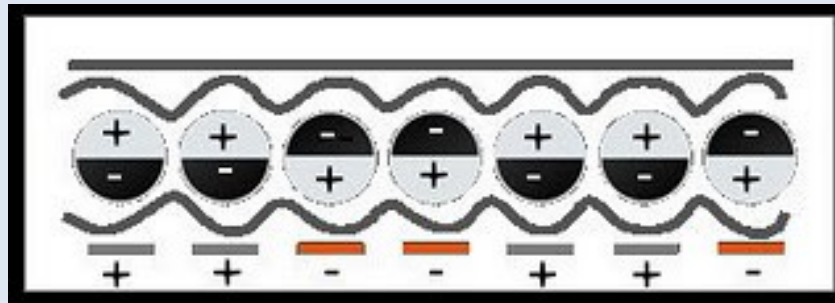
Properties: Reflects light like ordinary paper



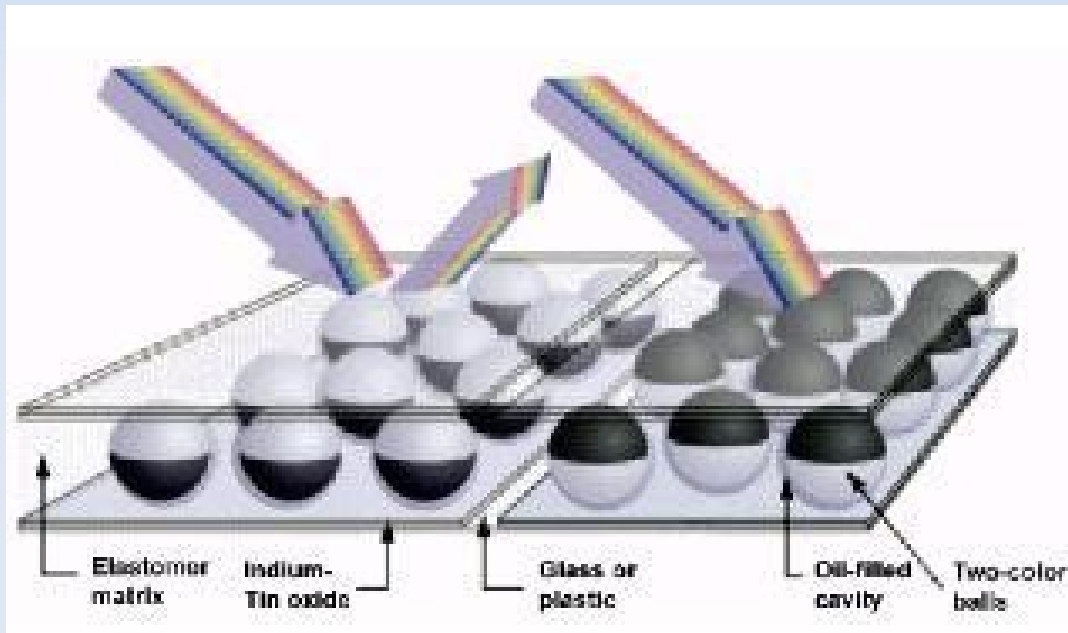
Gyricon

(the first one)

- Developed in the 1970s by Nick Sheridan at Xerox's Palo Alto Research Center
- Polyethylene spheres between 75–106 μm (micrometres)
- Each sphere is a dipole with black and white sides, embedded in a transparent silicone sheet
- The spheres float in oil so they can rotate freely



Gyricon: example



Electroretic

(the simplest one)

"All the News That's Fit to Print."

THE WEATHER
Fair today and tomorrow; showers on Wednesday and Thursday.

VOL. LXXVII, NO. 31834
TWO CENTS
NEW YORK, MONDAY, NOVEMBER 11, 1918. TWENTY-FOUR PAGES

ARMISTICE SIGNED, END OF THE WAR! BERLIN SEIZED BY REVOLUTIONARIES; NEW CHANCELLOR BEGS FOR ORDER; OUSTED KAISER FLEES TO HOLLAND

SON FLEES WITH EX-KAISER
Hindenburg Believed to Be Among Those in His Party.

ALL ARE HEAVILY ARMED
Austrians Bring with Rifle as Fugitives Arrive at Dutch Frontier.

ON THEIR WAY TO DE STEES
Belgium Vail to There, "Are You On Your Way to Paris?"

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Practically the whole German General Staff accompanied the former Emperor, and the automobiles were heavily armed with rifles, machine guns and pistols. The Emperor's party was believed to include the members of the staff, the former Emperor, the Emperor's son, and the Emperor's daughter-in-law. A few minutes later, according to reports from the Hague, the Emperor's party was seen to cross the Dutch frontier at 7:30 o'clock Sunday morning, and to head for the Hague.

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KAISER FOUGHT HINDENBURG'S CALL FOR ABOLITION; Failed to Get Army's Support in Keeping Throne

By GEORGE BENJAMIN.
AMSTERDAM, Nov. 10.—The Kaiser's flight from Germany today was a dramatic event, the result of a long and bitter struggle. The Kaiser, who had been in Germany since the beginning of the war, had been fighting a losing battle against the revolutionaries. He had been fighting for the throne, but the revolutionaries had been fighting for the people. The Kaiser's flight was a sign of the end of the monarchy in Germany.

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Reids Shell Building in Which Officers Vainly Resist.

THROWING DEMAND REPUBLIC
Revolutionary Flag on Royal Palace—Crown Prince's Palace Also Seized.

GENERAL STRIKE IS BEGUN
Burgomaster and Police Sub-Office New Use Under Socialist Control.

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To Help Him Save Fatherland from Anarchy

REDEK, Nov. 10, (Continued from Page 1).—The Soviet Chancellor, Georgy Chicherin, today appealed to all Germans to help him save his fatherland from anarchy. He said that the revolutionaries in Germany were fighting for the people, and that the Kaiser was fighting for the throne. He said that the revolutionaries were fighting for the people, and that the Kaiser was fighting for the throne. He said that the revolutionaries were fighting for the people, and that the Kaiser was fighting for the throne.

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Terms Including Withdrawal from Alsace-Lorraine, Disarming and Demobilization of Army and Navy, and Occupation of Strategic Naval and Military Points.

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The department's announcement simply said: "The armistice has been signed." The world war will end this morning at 6 o'clock, Washington time, 11 o'clock Paris time. The armistice was signed by the German representatives at midnight.

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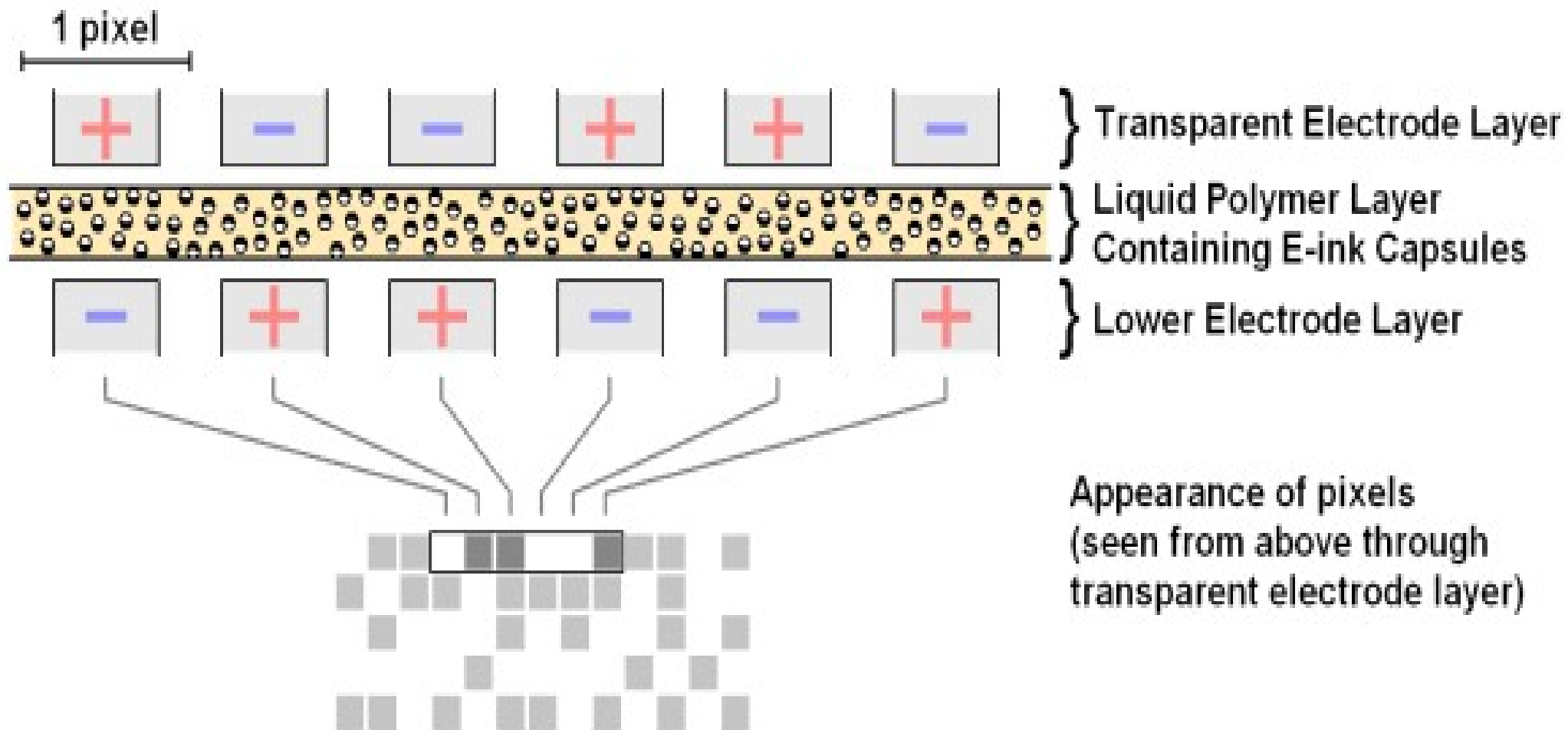
Delivery of part of the German High Seas Fleet and a certain number of submarines to the allied and American naval forces.

Disarmament of all other German warships.

Electrophoretic

- Titania particles $\sim 1\text{m}^{-6}$ in hydrocarbon oil
- Spheres between two parallel, conductive plates separated by a gap of 10 to 100 micrometres
- Dark-colored dye
- When a voltage is applied, the particles migrate to the plate with the opposite charge
- 40% reflectance rate

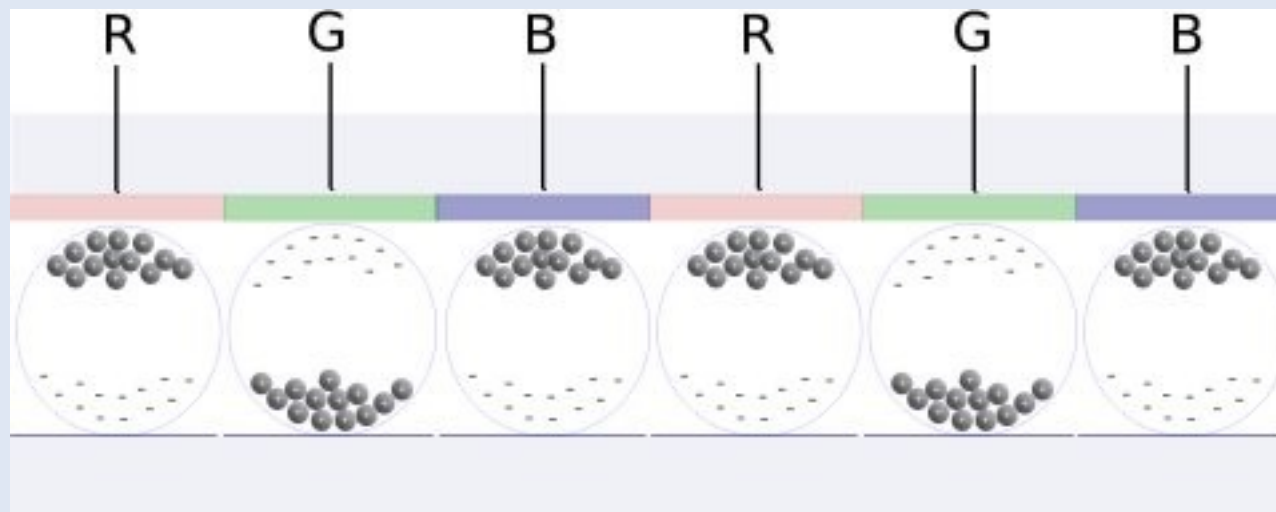
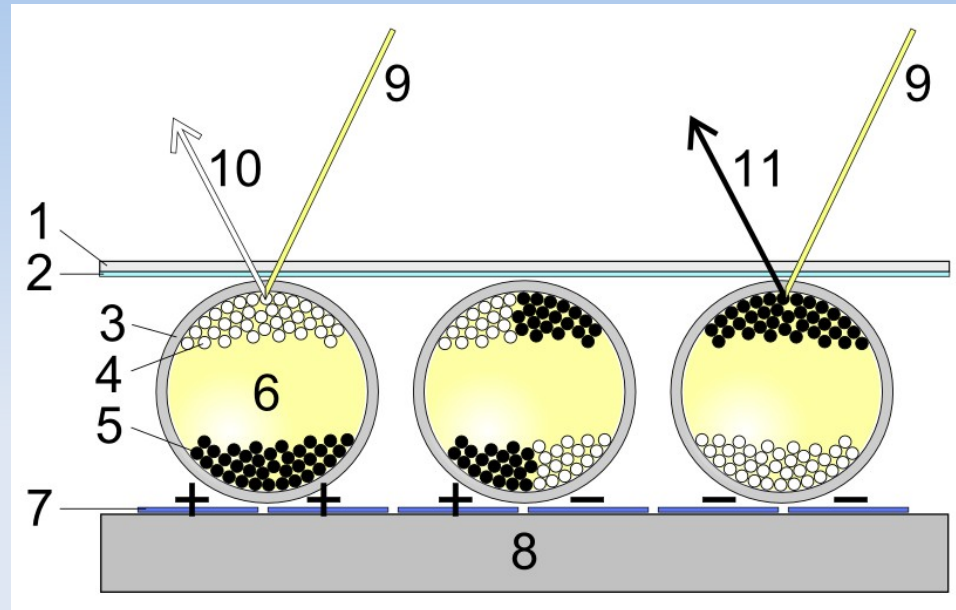
Electrophoresis



Electrophoretic display (the widespread one)

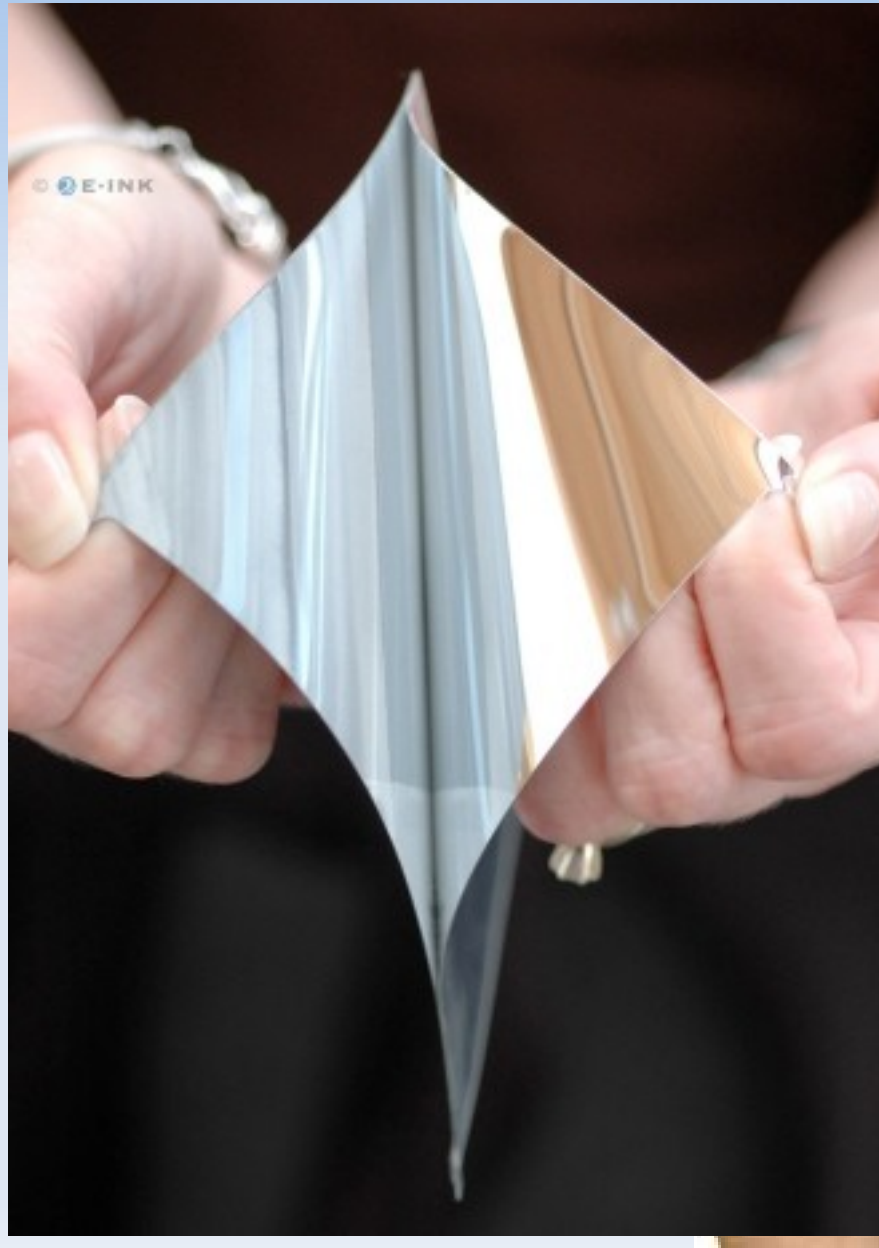
- Invented in 1990s by Joseph Jacobson, who later co-founded the E Ink Corporation
- Uses the same old electrophoretic technology: filled with colored oil and charged particles
- Transparent 40m^{-6} microcapsules in a layer of liquid polymer between two arrays of electrodes and plastic (80m^{-6} overall)
- It is possible to use only one layer of electrodes beneath the microcapsules
- 55% reflectance rate

Electrophoretic display



Electrophoretic display: examples

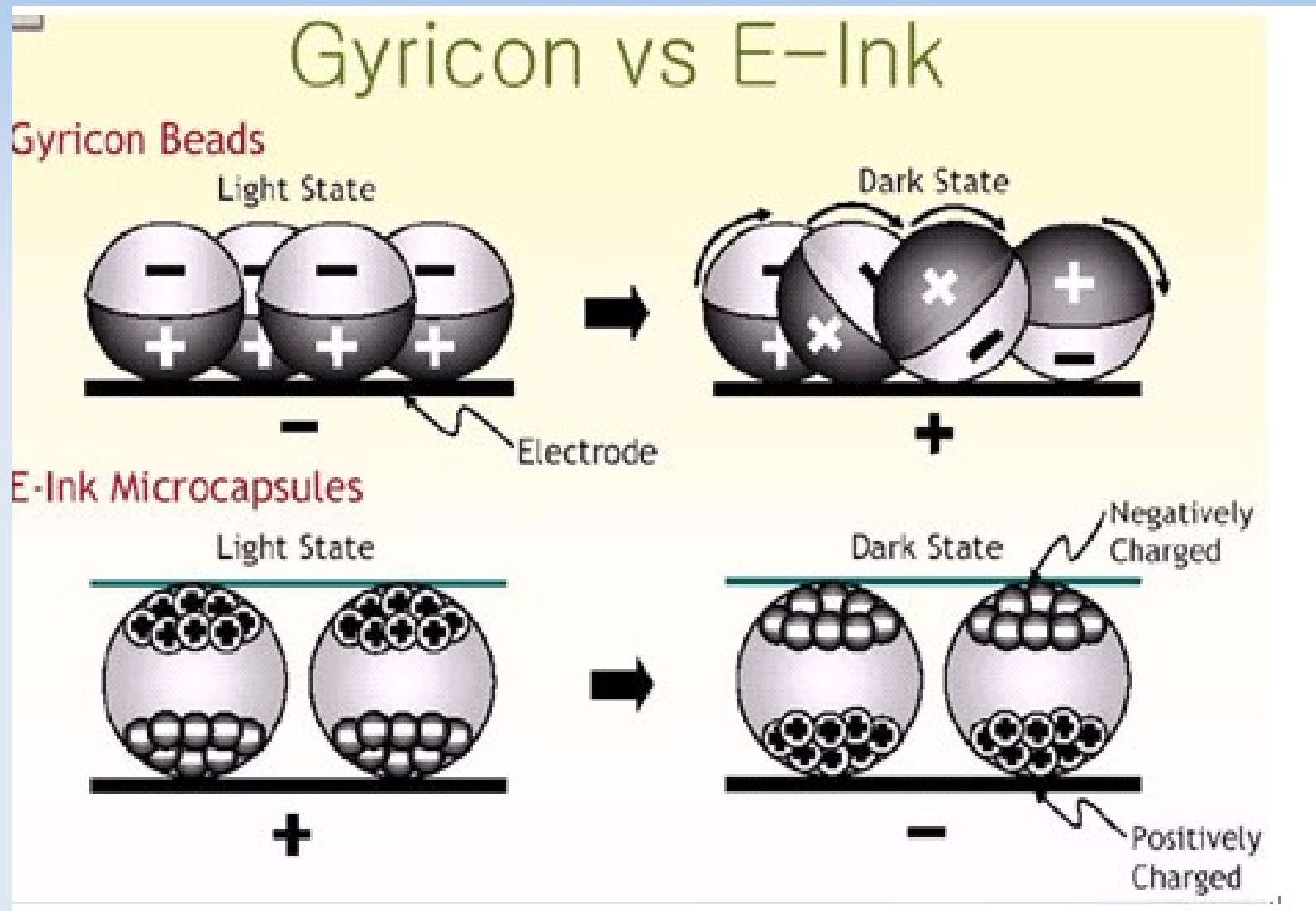
Motorola F3



Kindle



Comparison



Electrophoretic display disadvantages

- Very low refresh rate
- Ghosting effect
- In a R&D stage (research and development)
- Low reflectance rate



Electrowetting

(the fast one)

"All the News That's Fit to Print."

The New York Times.

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Practically the whole German General Staff accompanied the former Emperor, and the authorities feared the party, the authorities were treating with rifle, and all the fugitives were armed.

The ex-emperor was accompanied by his eldest son, Friedrich Wilhelm, crown prince of Prussia, and several other members of the Imperial family. On the whole, the people were very quiet, and the fugitives were treated with respect. The fugitives were treated with respect, and the people were very quiet.

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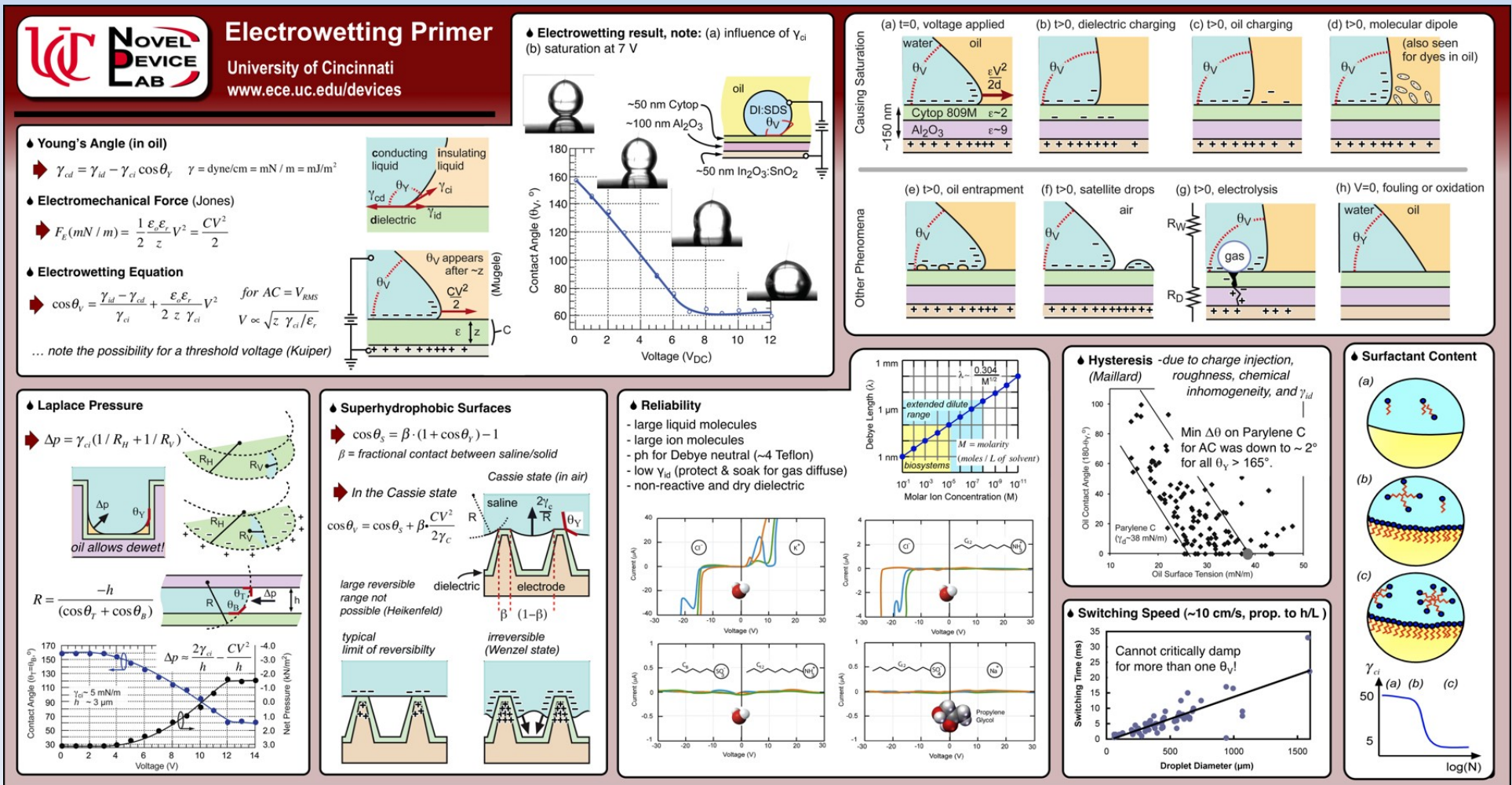
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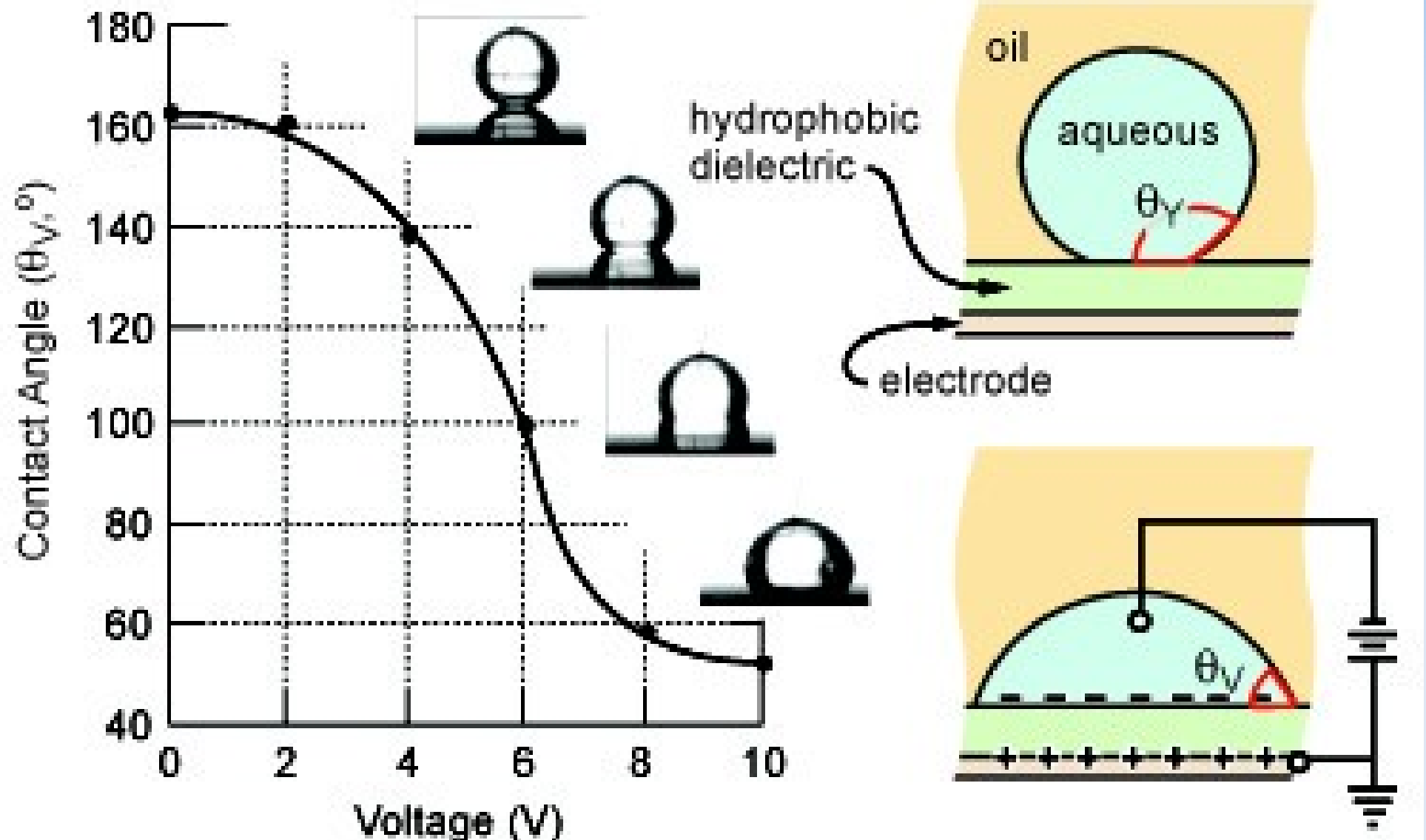
Disarmament of all other German warships.

Electrowetting effect

Gibbs free energy required a certain area of the ink surface.
There are both chemical and electrical components.



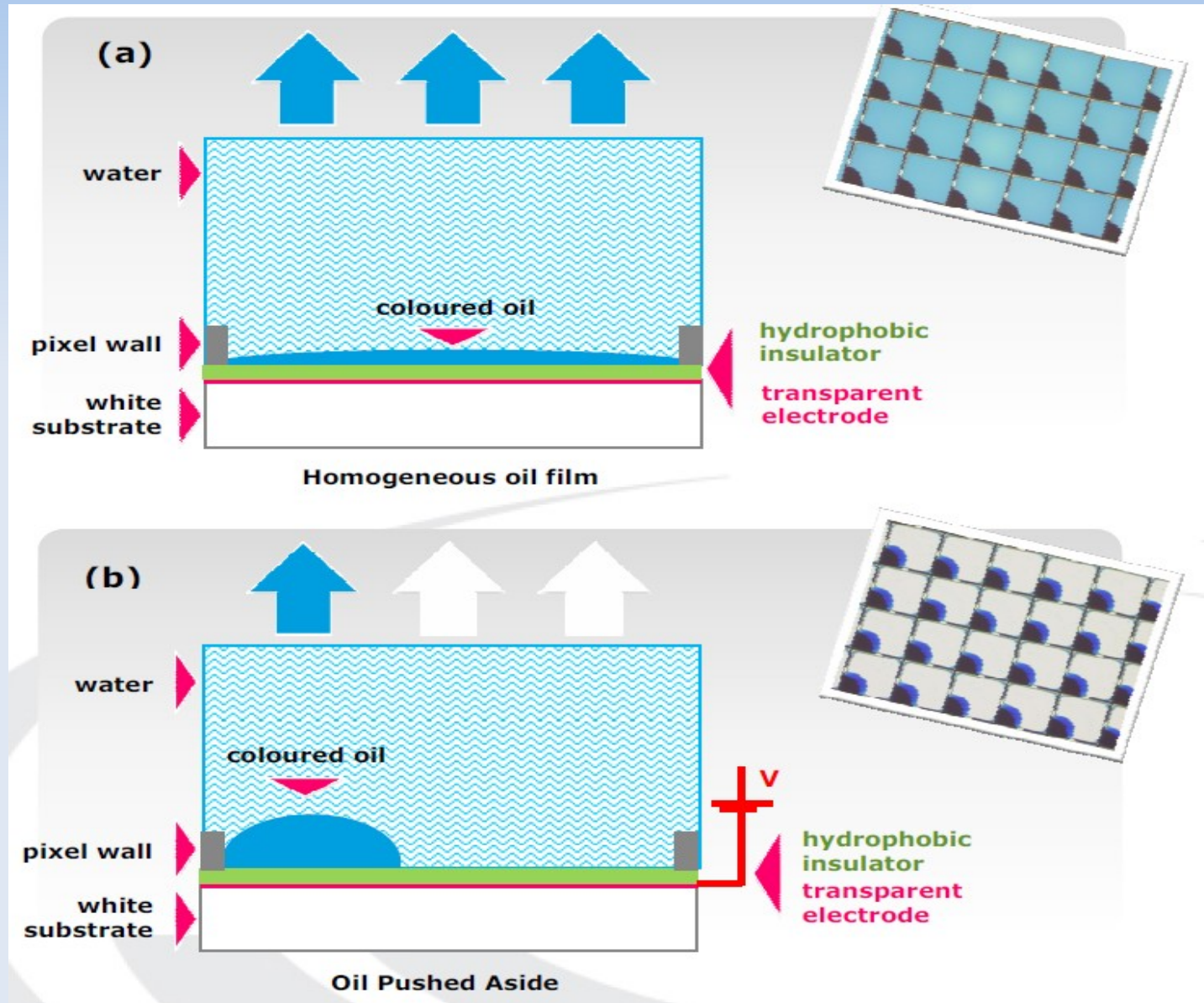
Electrowetting effect



Electrowetting

- Electro-wetting display controls the shape of the water/oil by an applied voltage
- With no voltage applied, the (coloured) oil forms a flat film between the water and a hydrophobic electrode, resulting in a coloured pixel
- Switching between white and coloured reflection is fast enough to display video content
- 55% reflectance rate (expected to rise to 85%)

Electrowetting



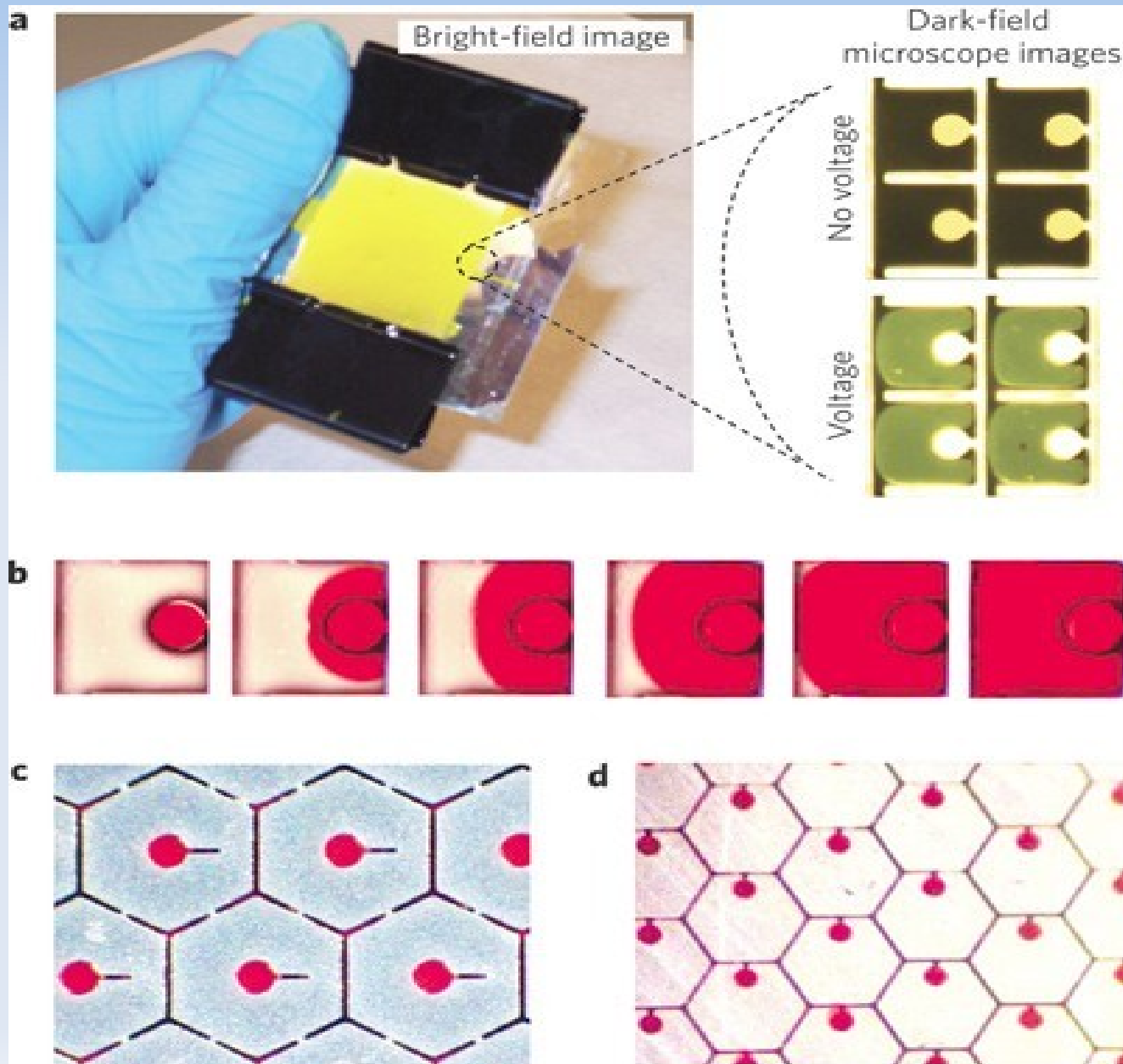
Electrowetting: animation hopes



Electrofluidic

- A variation of electrowetting displays
- Pigment inside a tiny reservoir (<5-10% of the pixel) instead of floating freely in water
- Aluminum layer reflects light
- Electromechanical pressure pulls the ink from the reservoirs into the channels
- Could have reflectance rate >85%

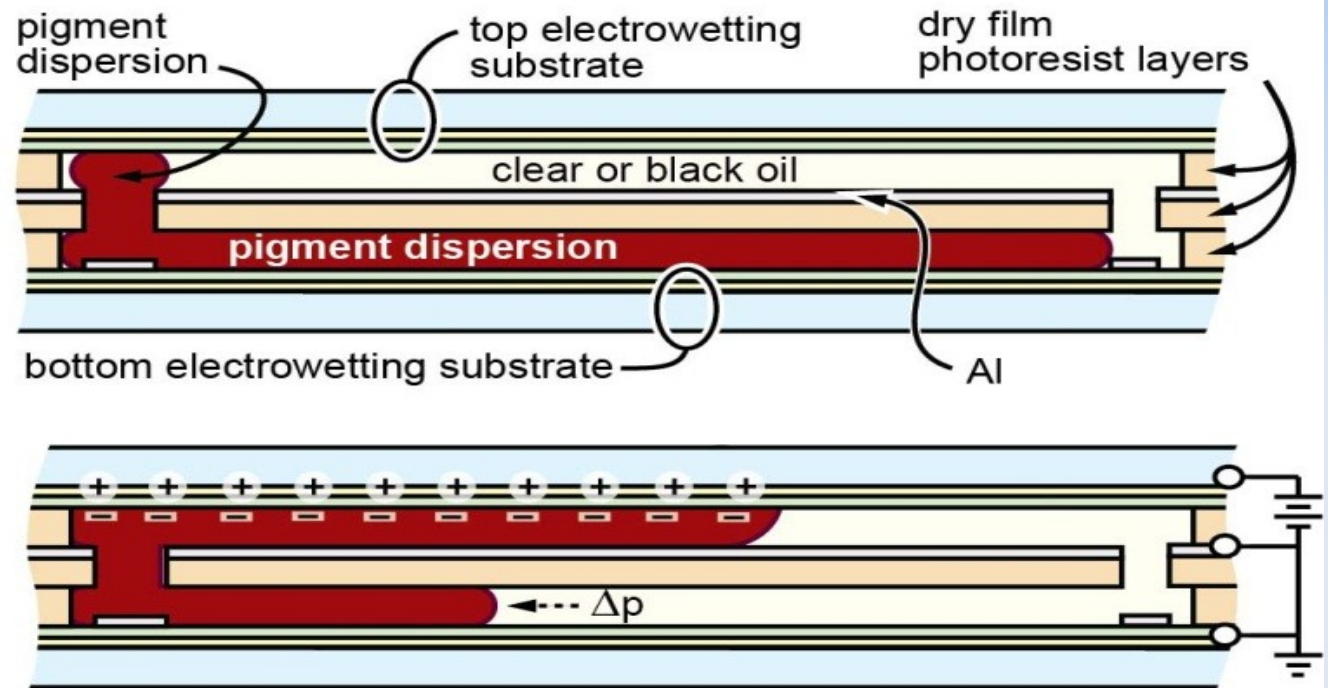
Electrofluidic display: cells



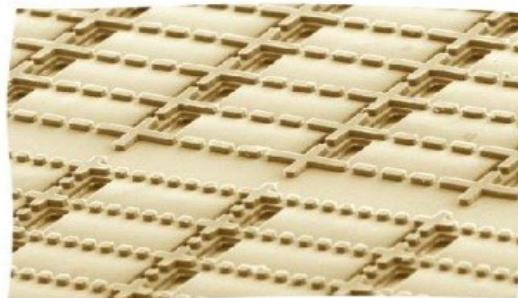
Electrofluidic Display: Multi-stable (2010)

University of
Cincinnati

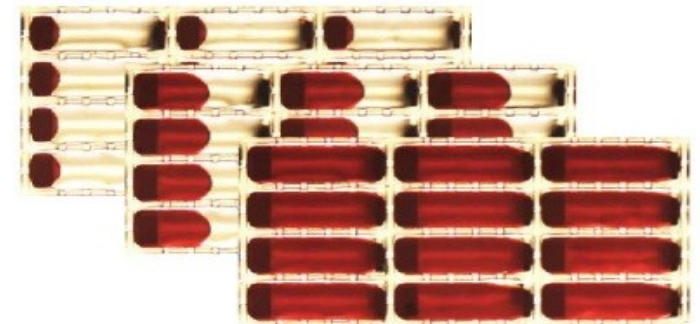
(a) cross-section view (not to scale)



(b) SEM of pixel array



(c) grayscales without voltage applied



Electrofluidic: Gammadynamic products

White state: 60-70%

Resolution: 75-300 DPI

Contrast ratio: >10:1

Viewing Angle: unlimited

Grayscale: 8-16 digital states

Colors: 1024

Saturation: >40%

Speed: <30 ms

Bistable: infinite

Voltage: 15V, single TFT active-matrix

Thickness: <40 μm active layer



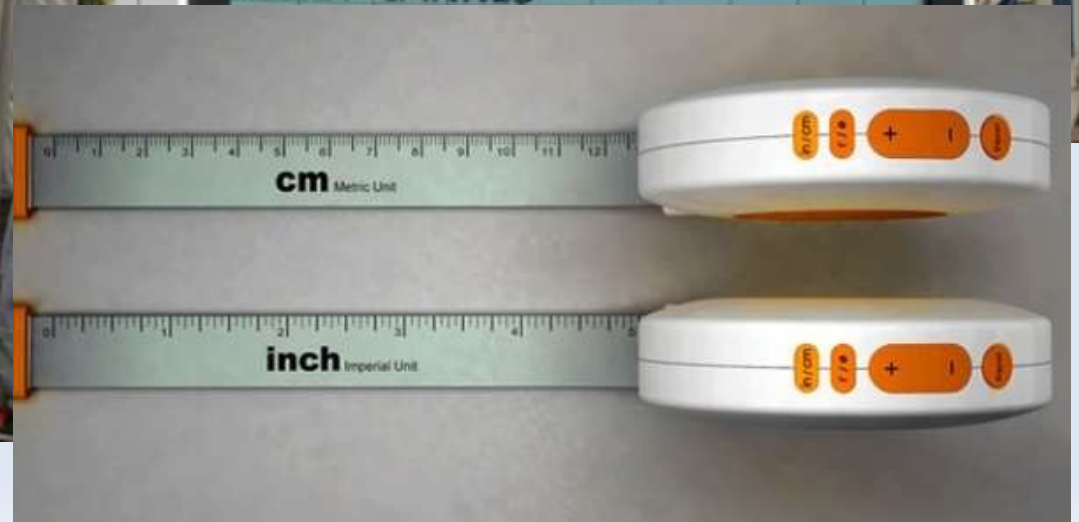
Applications: Gadgets



Applications: More gadgets



Applications: WTF



Britains using E-Ink to make tanks invisible



Comments



Main resources:

- http://en.wikipedia.org/wiki/Electronic_Paper (01.11.2011)
- <http://www.epapercentral.com/electrofluidic-technology-enters-epaper-arena.htm>
- http://secs.ceas.uc.edu/devices/NDL_Research.html
- http://secs.ceas.uc.edu/devices/NDL_Video.html
- <http://gammadynamics.net/>