

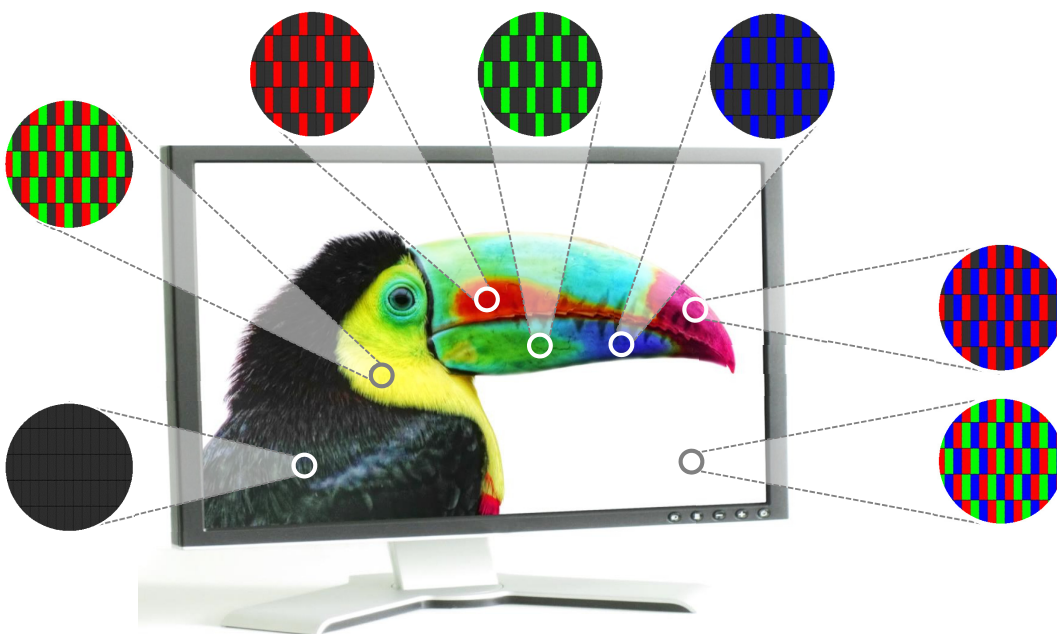
BASF Research Press Conference  
on May 27, 2014

## High performance color filters improve the brilliancy of liquid crystal displays

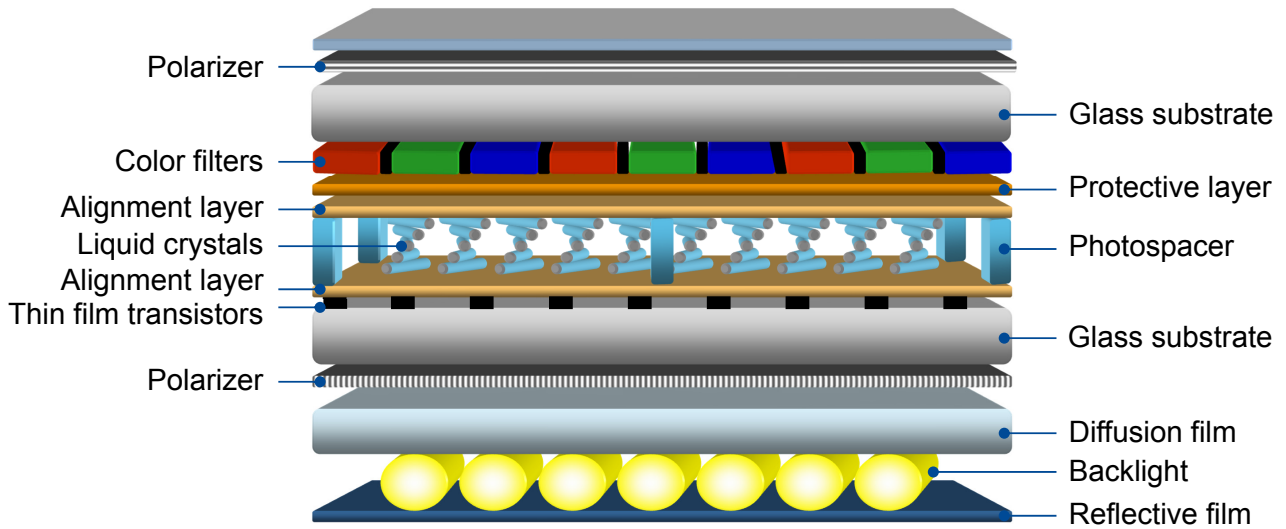


Dr. Hans Reichert  
Head of Colorants Research, BASF Schweiz AG, Basel

### A closer look at a full color liquid crystal display

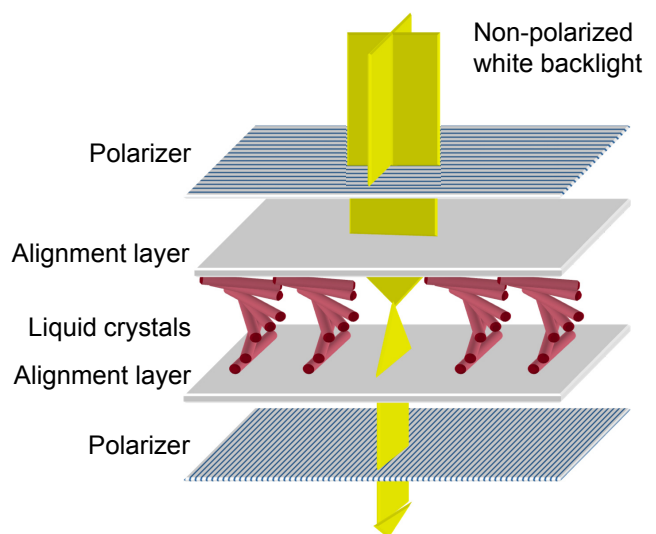


# Cross-section of a display



# Liquid crystals as a light switch Illuminated state

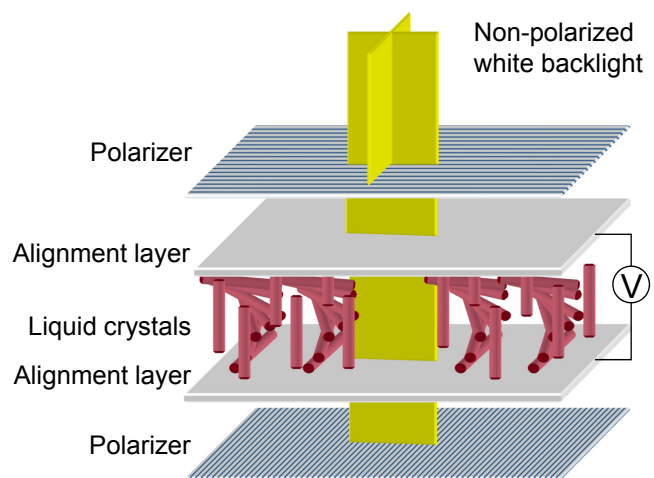
- Liquid crystals align with a helical twist between predefined alignment layers
- Non-polarized backlight is polarized by first polarization filter
- Polarization plane of the light is twisted while passing through the liquid crystals
- Light with twisted polarization plane can pass through second polarizer
- Display is illuminated



# Liquid crystals as a light switch

## Dark state

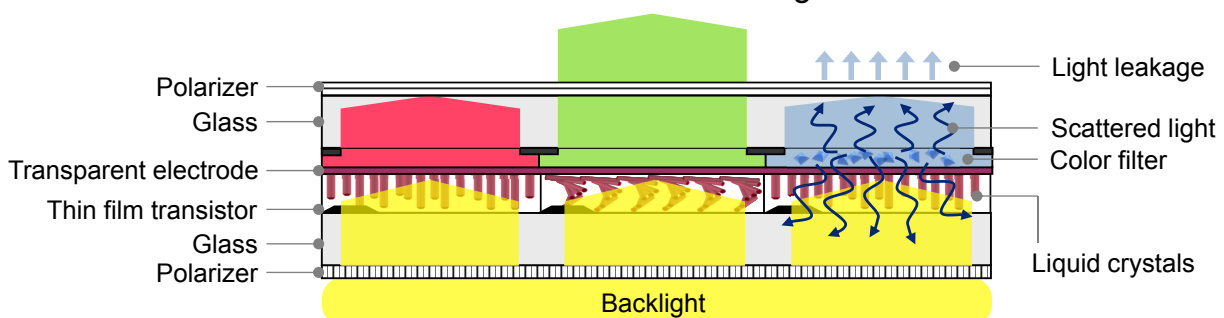
- Applying a voltage between the alignment layers causes the liquid crystals to stand upright
- Polarized light passes through liquid crystal cell without being twisted
- Light cannot pass second polarizer
- Display is dark



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# Close-up of a pixel

- Each pixel is made of subpixels with red, green and blue color filters
- Each color filter is connected to a cell of liquid crystals to control the amount of light that can pass through
- Crystals can scatter and depolarize the light and cause light leakage
- Minimizing scattering leads to
  - ▶ Higher brightness
  - ▶ Higher brilliancy
  - ▶ Higher contrast ratio

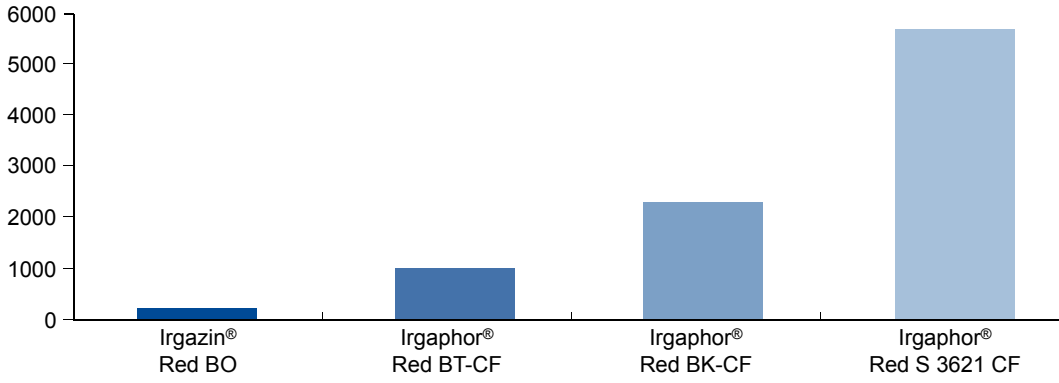


The smaller the crystals the lower the scattering and the better the display

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# Development of red color filter grades

Contrast ratio



paint grade  
not usable for color  
filter applications  
due to low contrast  
ratio

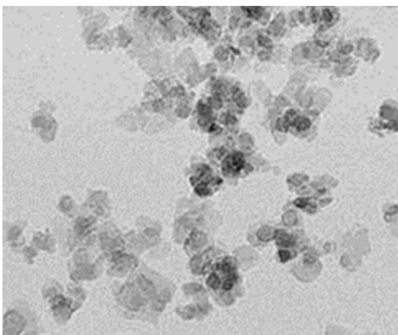
first color filter grade  
launched in 1997

launched in 2005,  
used in mobile,  
monitor and TV  
applications

since 2013 state  
of the art color filter  
red, used in high end  
TVs and tablet PCs

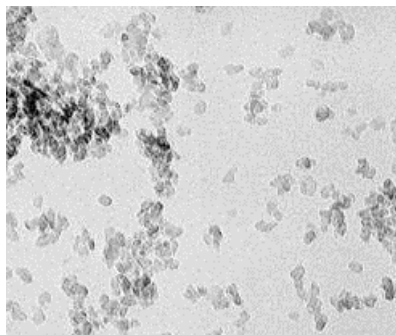
# Electron microscope pictures of red color filter grades

**Irgaphor®  
Red BT-CF**



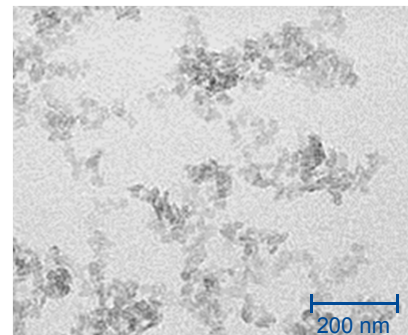
[ca. 80nm]  
Contrast ratio: 1000

**Irgaphor®  
Red BK-CF**



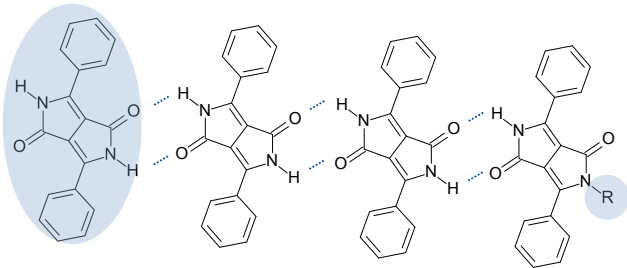
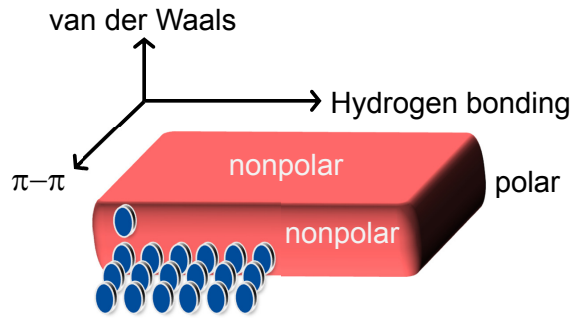
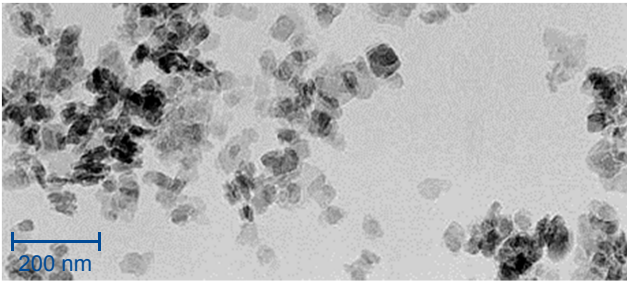
[ca. 40nm]  
Contrast ratio: 2500

**Irgaphor®  
Red S 3621 CF**



[< 40nm]  
Contrast ratio > 5500

# Crystal morphology – platelet-like structures



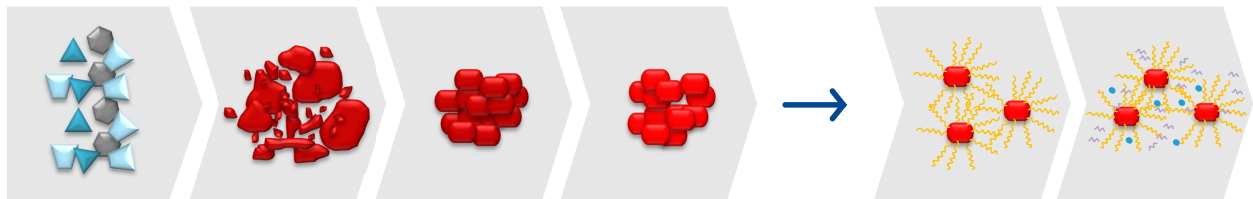
Growth rate:

hydrogen bonds >  $\pi-\pi$  interactions > van der Waals interactions

# From raw materials to color filters

Synthesis    Micronization    Surface treatment

Dispersant, Binder    Photoinitiator, Monomer

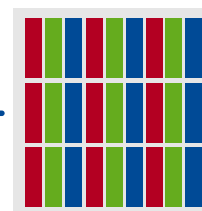


Raw materials    Crude colorant    Micronized particles    Color filter grade

Dispersion    Resist formulation

## Our contribution to LCD performance

Higher image quality (color purity, contrast, brightness) and higher productivity



Color filter production by photolithography

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# Nanotechnology

Small dimensions – great opportunities



 **BASF**  
The Chemical Company