MCA TECHNOLOGIES GmbH
(Switzerland)

Visions of tomorrow's chemical technologies: Pointers and pathways

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Key words: Environmentally friendly technologies and yet cost effective, Nanotechnologies, Colour beyond appearance, CO2 capture as raw material, Fire retardance of plastics and coatings, "Seed" concept in textiles.

MCA Technologies GmbH, Switzerland

M C A TECHNOLOGIES GmbH (Switzerland)

Supporting R&D & Business Development in Life Sciences, and Specialty Chemicals Industries

- **How: Cost, risk and benefit sharing**
- **Our contribution: Financial and intellectual support**
- **Our objective: Competitive edge (products, technologies, services)**
- **Seeking collaborations, partners, entrepreneurs**

1 **Polytriazinyl compounds as flame retardants and light stabilizers**
Inventor: KAUL BANSI LAL [CH]
Applicant: MCA TECHNOLOGIES GMBH [CH]
EP2130854 (A2) - 2009-12-09

2 **Process for the Preparation of Organic Materials**
Inventor: KAUL BANSI LAL [CH]
Applicant: MCA TECHNOLOGIES GMBH [CH]
EC: C09B67/00N2; C08K5/00P4; (+1)
IPC: *B32B27/10; B32B27/34; B32B27/38;* (+19)
US2009017307 (A1) - 2009-01-15

3 **Process for the Preparation of Organic Materials**
Inventor: KAUL BANSI L [CH]
Applicant: MCA TECHNOLOGIES GMBH [CH]
EC: C09B67/00B9; C09B25/00; (+2)
IPC: *C08K5/00;* C08K5/00
US2008060554 (A1) - 2008-03-13

4 **Process for the preparation of organic materials**
Inventor: KAUL BANSI L [CH]
Applicant: MCA TECHNOLOGIES GMBH [CH]
EC: C09B48/00; C09B25/00; (+2)
IPC: *C08K5/00; C09B25/00; C09B48/00;* (+7)
US2007119345 (A1) - 2007-05-31

5 **Process for the preparation of fluorescet and non-fluorescent pigments**
Inventor: KAUL BANSI L [CH]
Applicant: MCA TECHNOLOGIES GMBH [CH]
EC: C09B67/00N2
IPC: *C09K11/02; C03C17/00; C09B67/20;* (+3)
US2006063855 (A1) - 2006-03-23

6 **SOLVENT-FREE PROCESS FOR THE PREPARATION OF DIKETOPYRROLOPYRROLE DERIVATIVES**
Inventor: KAUL BANSI LAL [CH]
Applicant: MCA TECHNOLOGIES GMBH [CH]
EC: C07D401/04; C07D209/46; (+6)
IPC: *C07D209/46; C07D401/04; C07D403/14;* (+16)
KR20050106460 (A) - 2005-11-09

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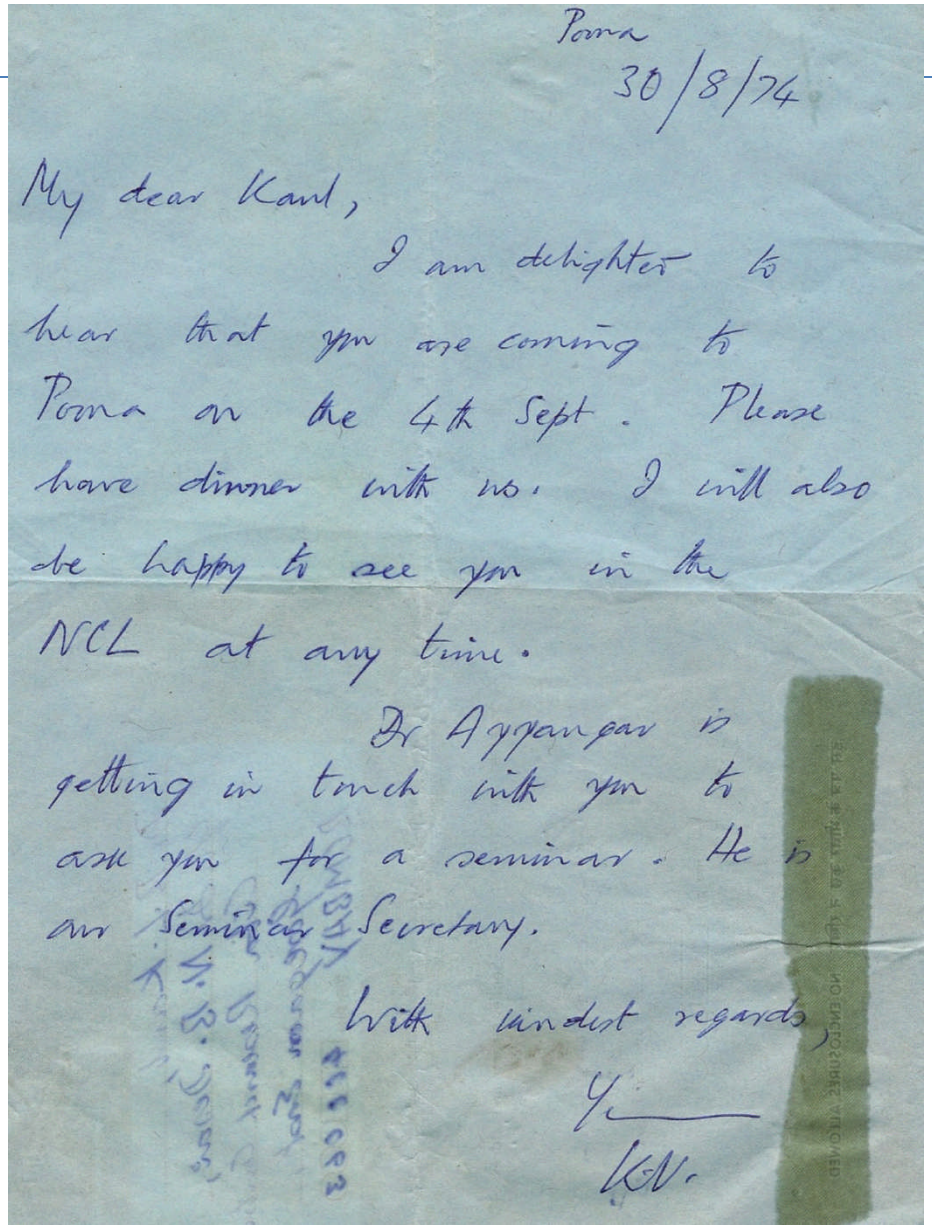
Patents:
MCA Technologies GmbH

Our commitment to novel technologies

Down the road of memory with KV



Poona
30/8/74

My dear Karl,

I am delighted to hear that you are coming to Poona on the 4th Sept. Please have dinner with us. I will also be happy to see you in the NCL at any time.

Dr Appaiyar is getting in touch with you to ask you for a seminar. He is our Seminar Secretary.

With kindest regards,

Yours

K.V.

Code of composition of lac pigments: Colouring matters of Lac Larvae

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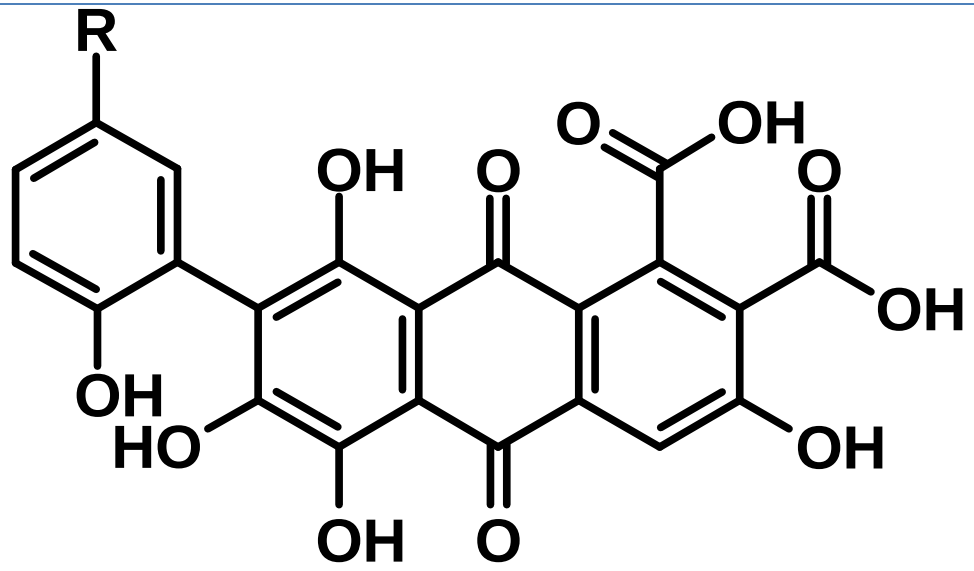

A : R = $CH_2CH_2COCH_3$
B : R = CH_2CH_2OH
C : R = $CH_2CH(NH_2)COOH$
E : R = $CH_2CH_2NH_2$

Mystery of the methylation of lac pigments (laccaic acid)

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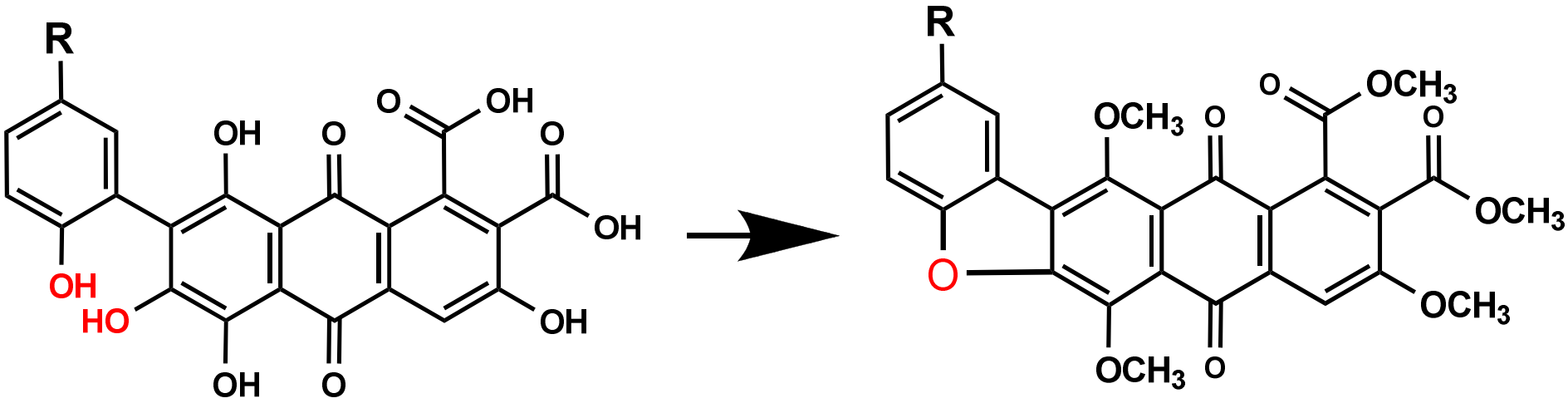
(Switzerland)



Mechanism of reactive dyeing

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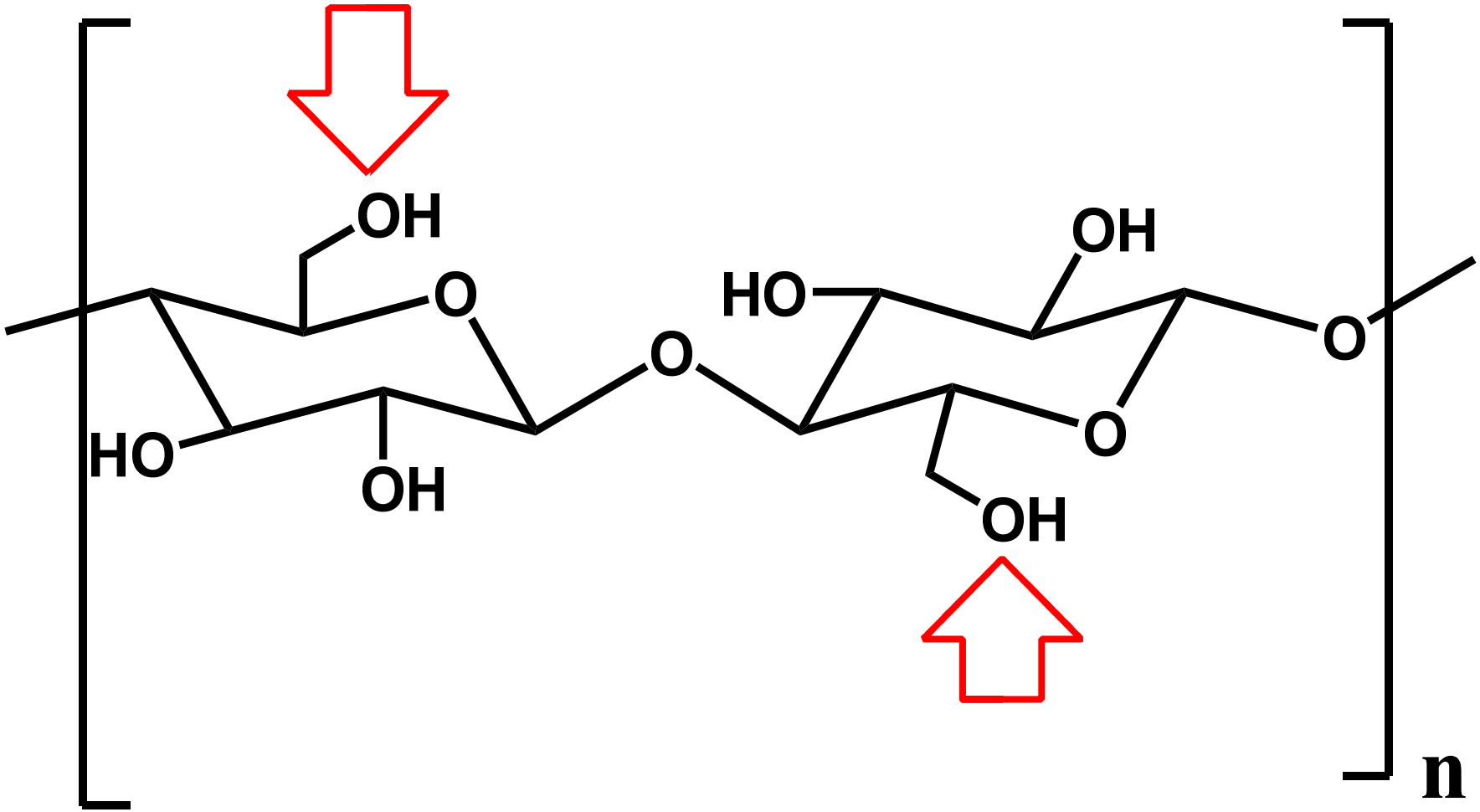
(Switzerland)



Environmentally friendly technologies, and yet cost effective

Pointers of chemical technologies of tomorrow

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- **Energy efficiency**: in which the exothermies/endothermies of the reactions are efficiently exploited for driving the reactions.
- **Cost efficiency**: higher productivity with same or less resources (equipment, man power and other investments)
- **Waste efficiency**: less waste & pollution
- **Safety efficiency**: Taming the chemistry
- **Over-all better value addition**

Pathways of chemical technologies of tomorrow

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- **Solvent-free processes**
- **Surface chemistry reactions (including heterogeneous catalysis and phase transfer reactions)**
- **Solid-state reactions**
- **Continuous/semi-continuous process (micro reactors, extrusions)**
- **Automation i.e. electronically remote-controlled processes**

Example: MCA® solvent-free technology of DPP pigments

DPP Pigments

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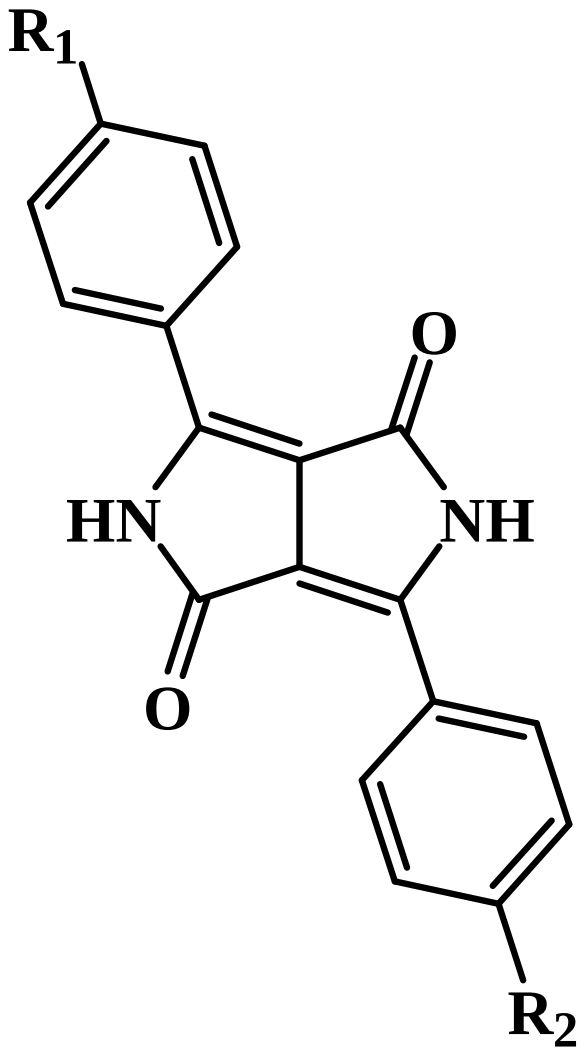
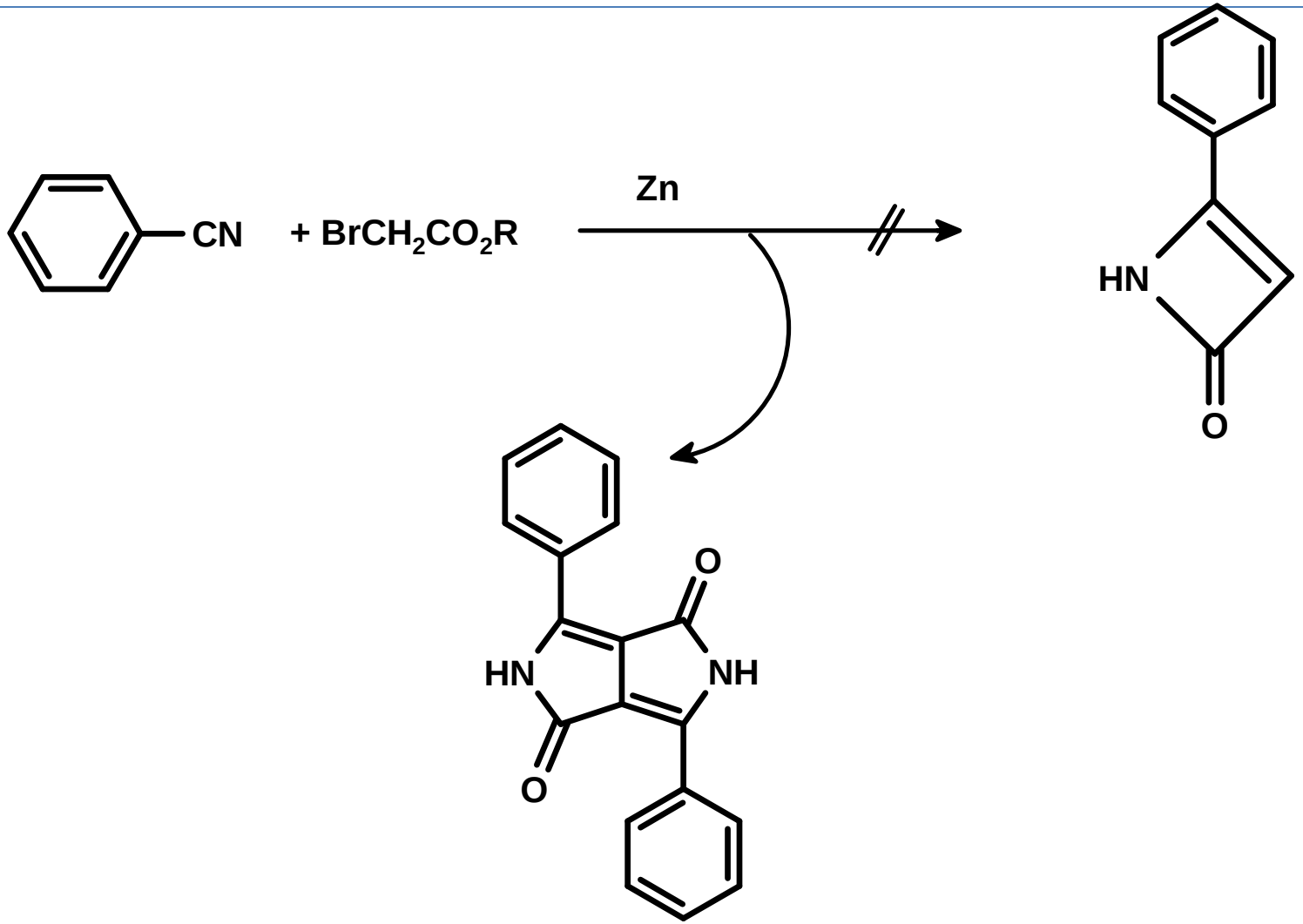


Synthesis of Diketopyrrolopyrole (Farnum-Metha synthesis, 1974)

M C A TECHNOLOGIES GmbH (Switzerland)



DPP State-of-the-art technology

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General Outline:

Reaction of two moles of a nitrile with one of diisioalkyl succinate in the presence of more than two moles of an exotic sodium tertiary-alkylate, in an absolutely inert and anhydrous solvent followed by hydrolysis and finishing:

For Example EP 61426 & 98808 (*Iqbal et al., 1982,1984*);
USP 6,375,732 *(Kaul , et. al, 2002)*

DPP State-of-the-art technology

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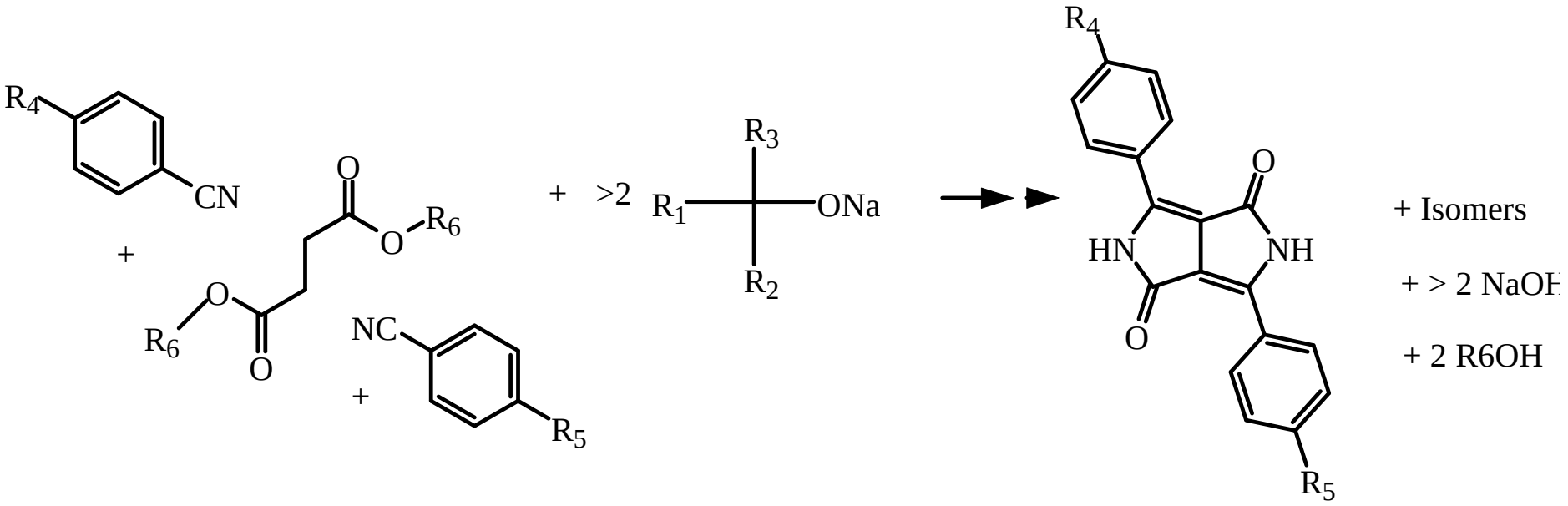
Reaction Scheme:



For Example EP 61426 & 98808 (*Iqbal et al., 1982,1984*);
USP 6,375,732 *(Kaul , et. al, 2002)*

Mechanism of the synthesis of diketopyrrolopyrole pigments

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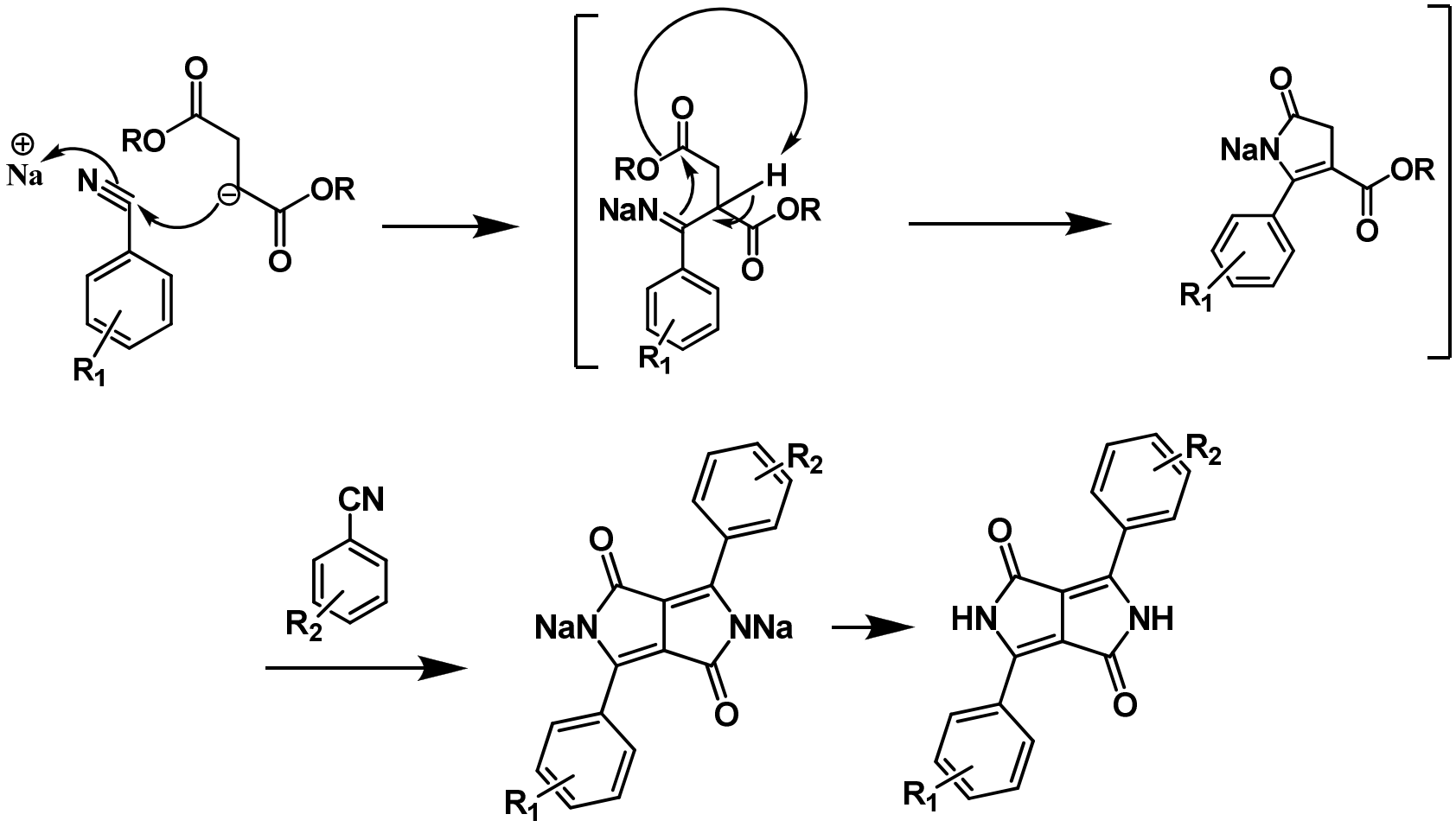

DPP State-of-the-art technology: By-products

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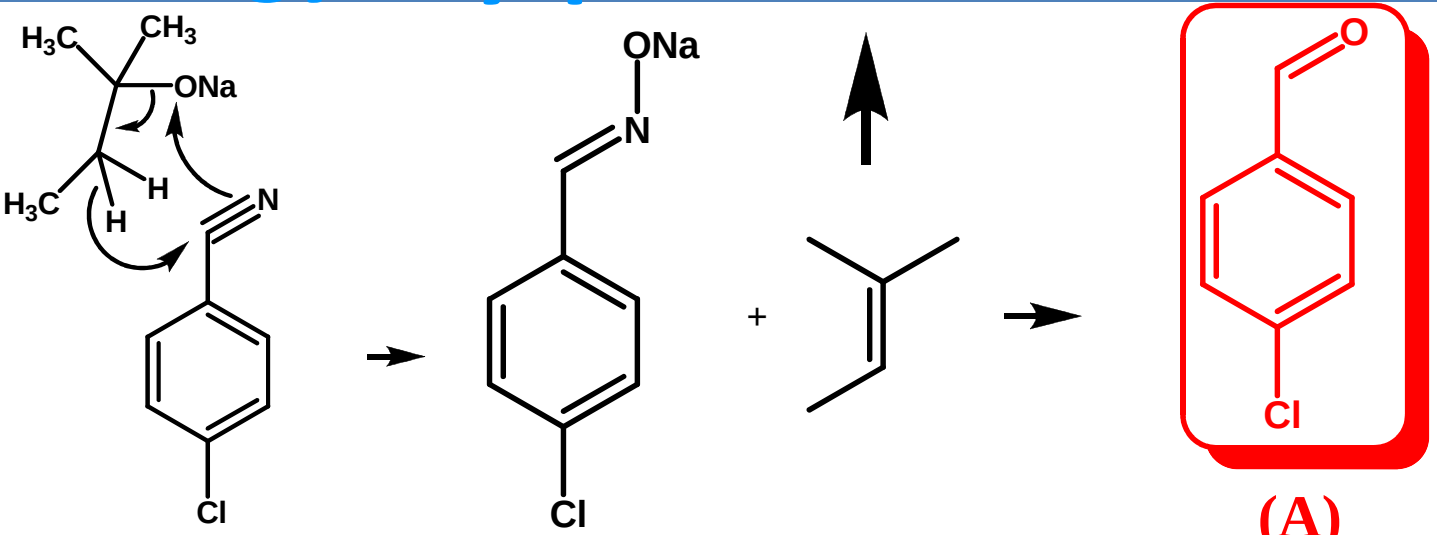
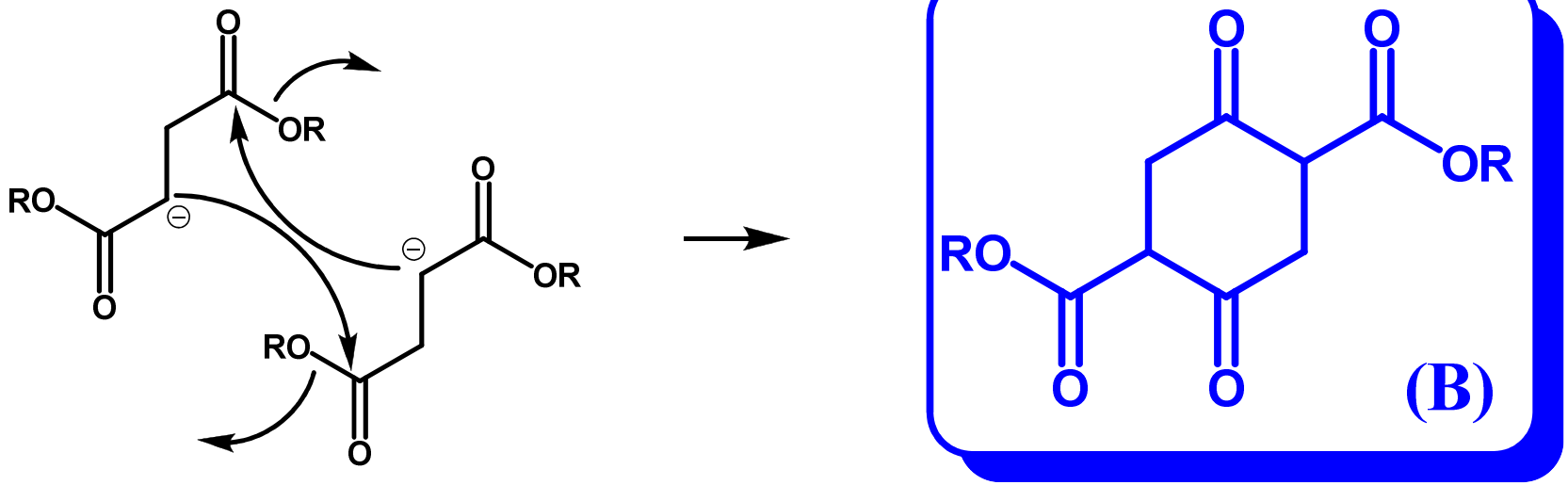
1)



(A)

2)



Corner stones of State-of-the-art DPP technology

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- Synthesis of the base
- Synthesis of the DPP disodium salt
- Formation of the crude pigment
- Purification & finishing of the crude (different solvent)
- Regeneration and rectification of the solvents
- Waste management

DPP State-of-the-art technology

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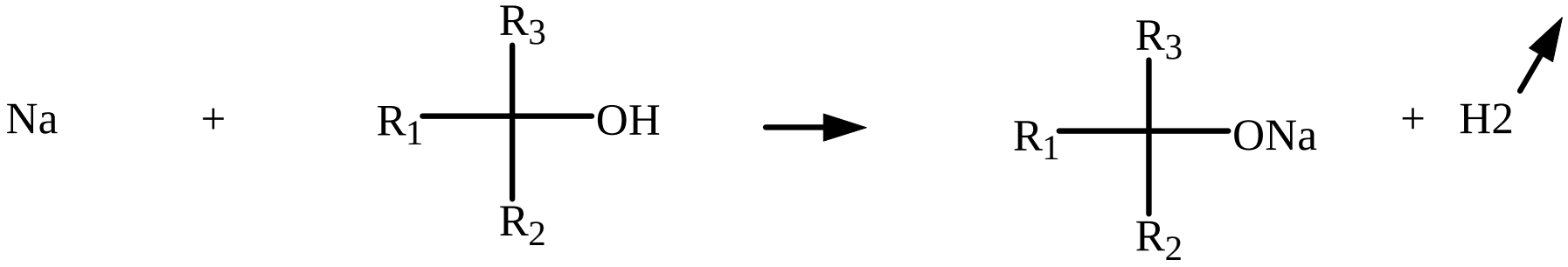
1. Synthesis of the base



Drawbacks:

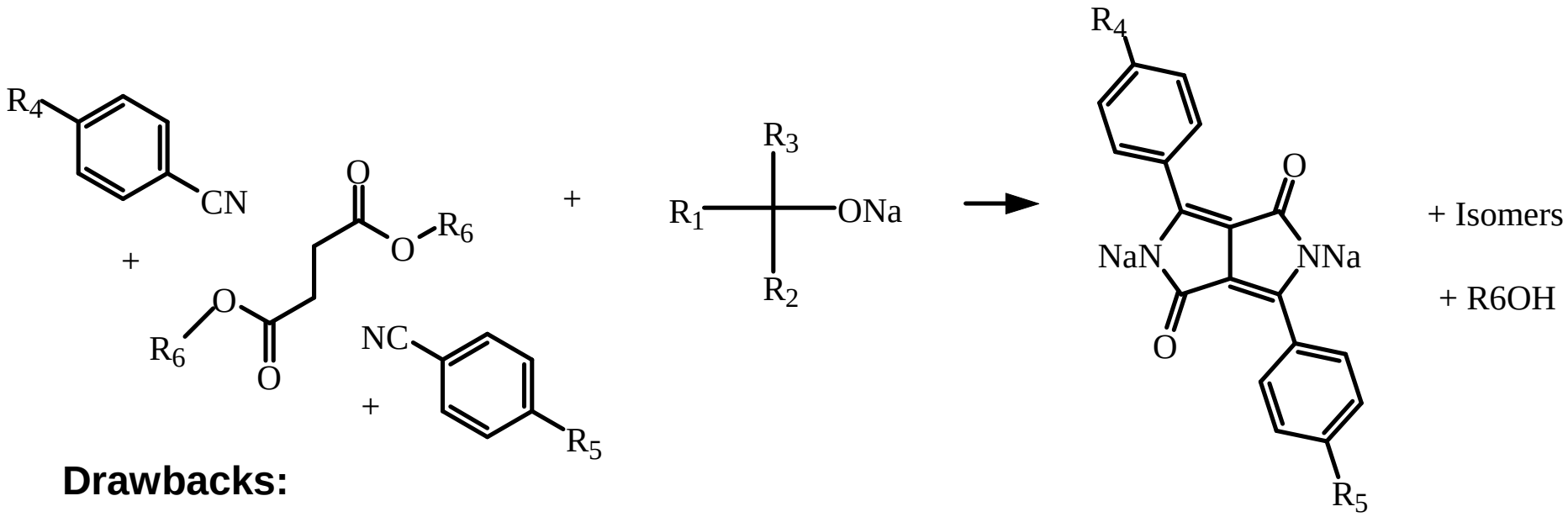
Hazard of storing and handling of sodium, an exotic reagent for a pigment producer

- **Very slow reaction, high energy costs/ low throughput**
- **Formation of extremely hazardous gaseous hydrogen**
- **Exotic and expensive base if purchased from outside**

DPP State-of-the-art technology

M C A TECHNOLOGIES GmbH (Switzerland)

2. Synthesis of the disodium salts of pigments



Drawbacks:

- **Use of high-purity, absolutely anhydrous exotic inert solvent**
- **Anhydrous conditions**
- **High dilution/low productivity due to high viscosity**
- **<u>Special stirring conditions, due to high viscosity</u>**

DPP State-of-the-art technology

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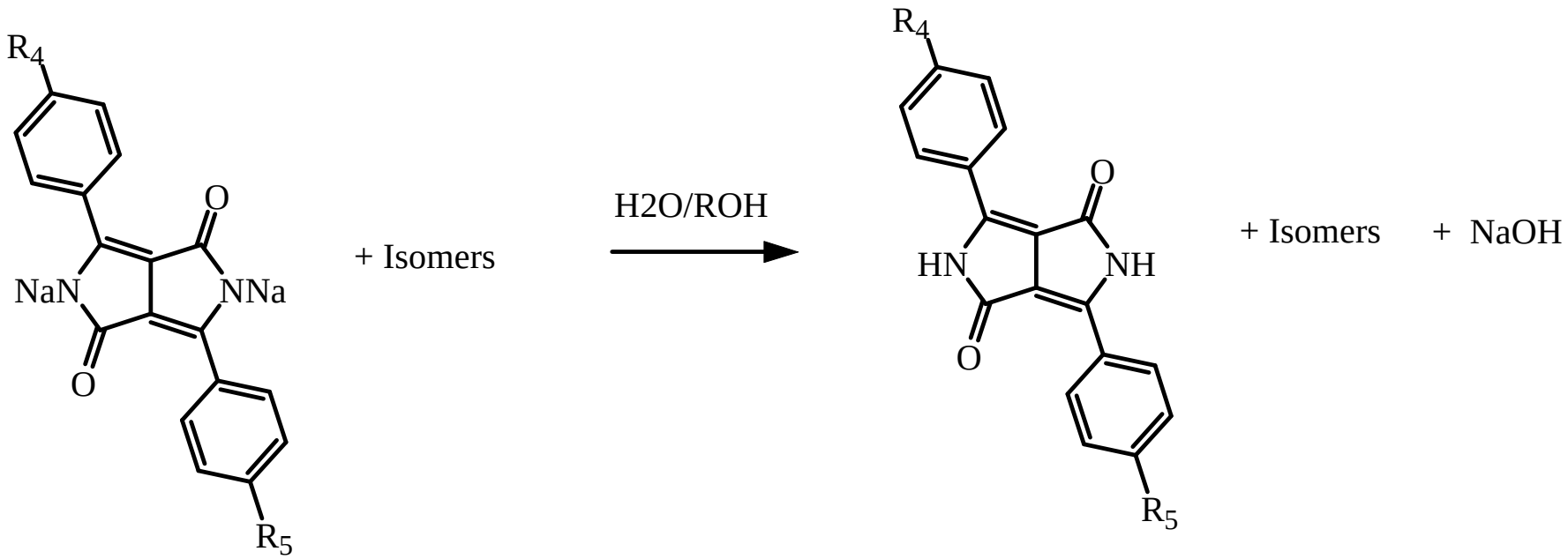
3. Synthesis of crude pigments



Drawbacks:

Tedious work-up

DPP State-of-the-art technology

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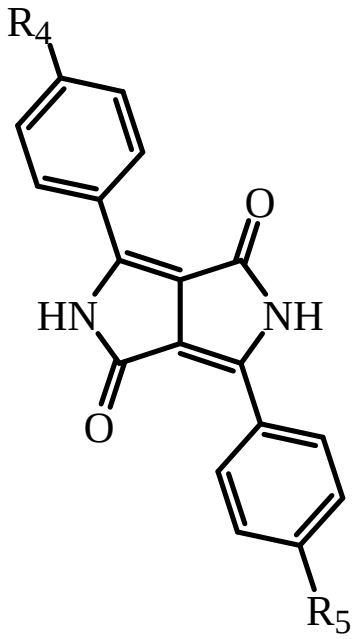
4. Finishing of pigments



+ Isomers

Drawbacks:

- **Cost**
- **High energy consumption**

DPP State-of-the-art technology

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5. Solvent recovery:

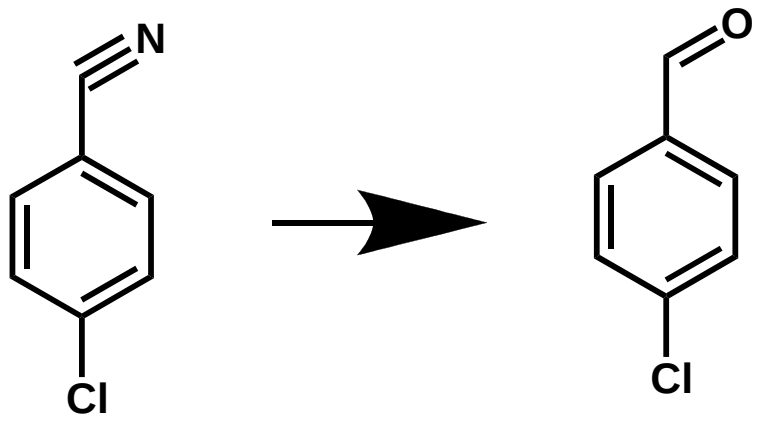
Absolute key success factor (pure and anhydrous)

Drawbacks:

- **Cost**
- **High energy consumption**
- **Waste (solvent losses)**

DPP State-of-the-art technology

6 . Formation of toxic aldehyde



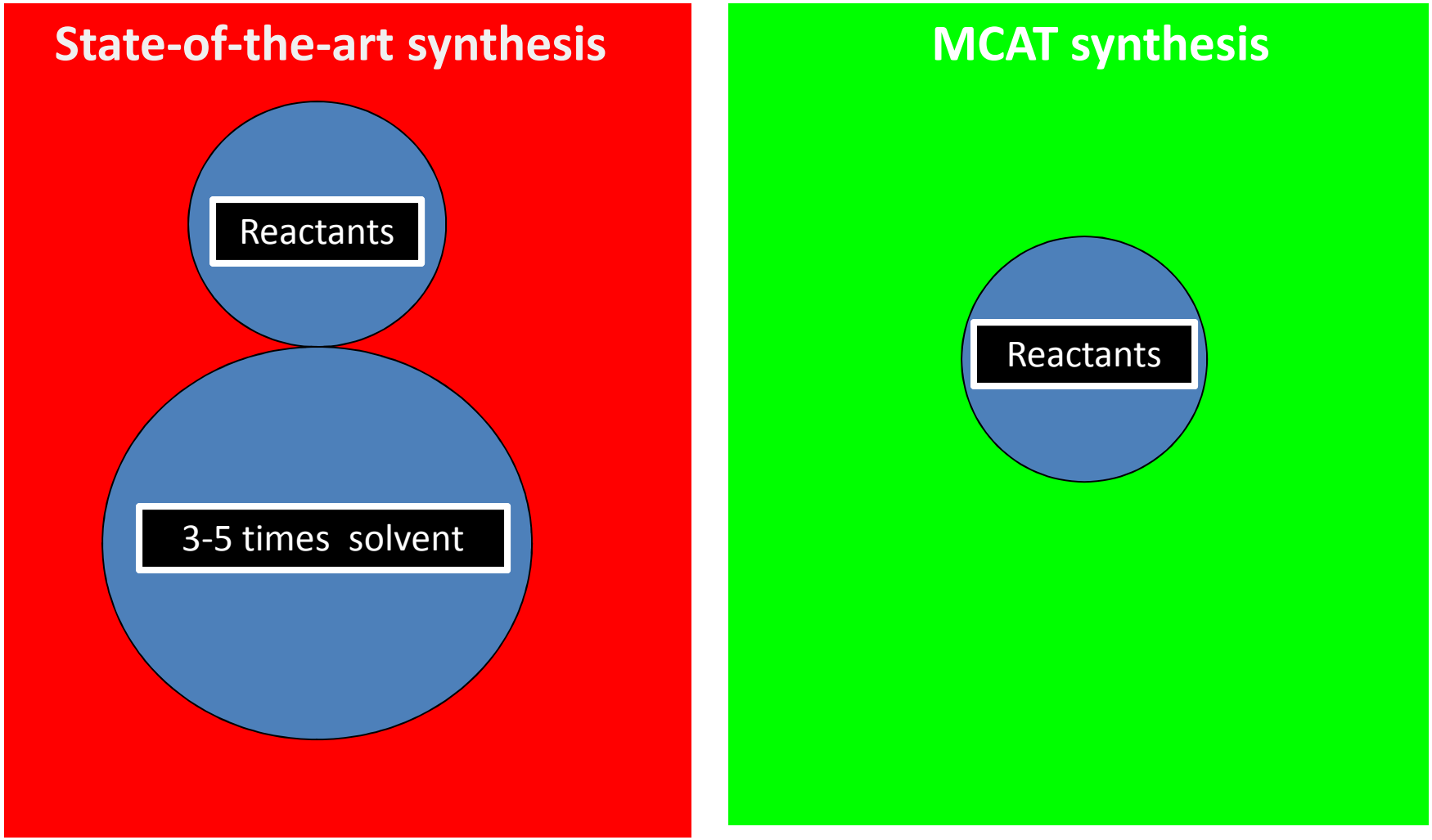
Drawbacks:

- **Waste , safety and environmental issues**

Solvent-free Synthesis

MCA® DPP pigment technology (Green Technology)

MCA TECHNOLOGIES GmbH (Switzerland)



MCA DPP Pigment Technology

versus

State-of-the-art DPP Pigment Technology

MCA® DPP pigments technology (Green Technology)

MCA TECHNOLOGIES GmbH (Switzerland)

Less energy demand

- Less total quantities of chemicals to heat and cool, for same quantity of the end-product
- Heat of reaction fully utilized to drive the reaction
- No tedious solvent recovery (fractionations) required

Est. Energy Demand Ratio = 5:1

MCA® DPP pigment technology (Green Technology)

M C A TECHNOLOGIES GmbH (Switzerland)

Higher productivity

- Much smaller reaction volumes/unit of end-product
- No solvent recovery and recycling required

MCA® DPP pigment technology

MCA TECHNOLOGIES GmbH (Switzerland)

Less safety risk

(in production & for the environment)

Less storage and handling of highly inflammable solvents

MCA® DPP pigment technology

MCA TECHNOLOGIES GmbH
(Switzerland)

Less waste

solvent losses, by-products

MCA® DPP pigment technology

MCA TECHNOLOGIES GmbH
(Switzerland)

Less investments and maintenance costs

for storage and tedious fractionation of the solvent

MCA® DPP pigment technology

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Quality

Regularly shaped nanoparticles (required for LCD)

MCA DPP Pigment technology: By-products formed : HPLC of the reaction mixtures

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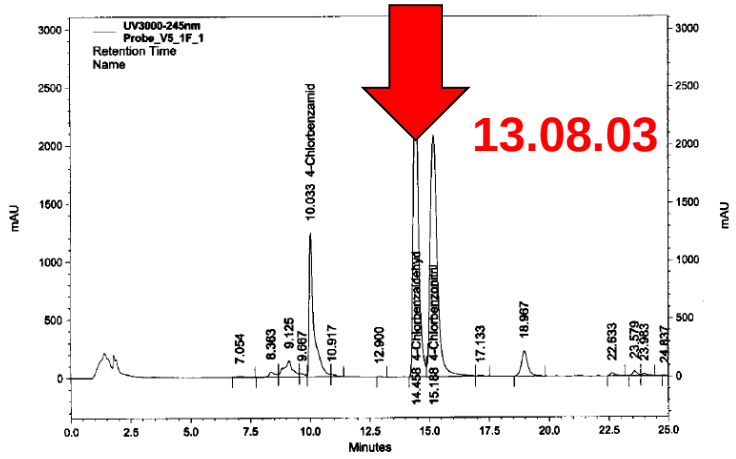
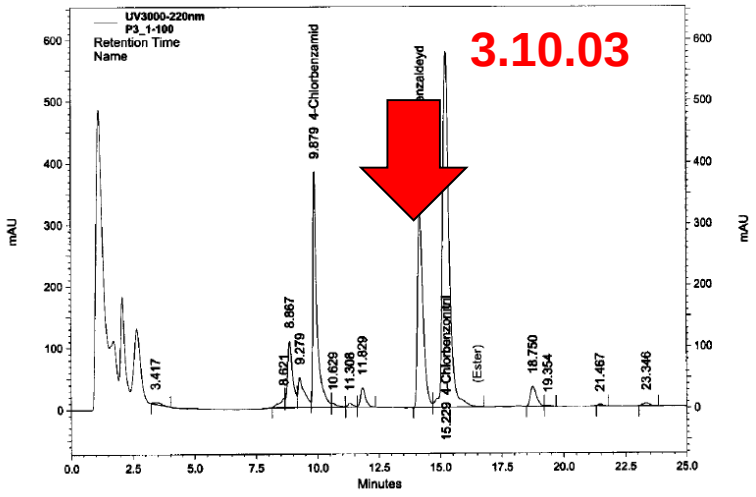
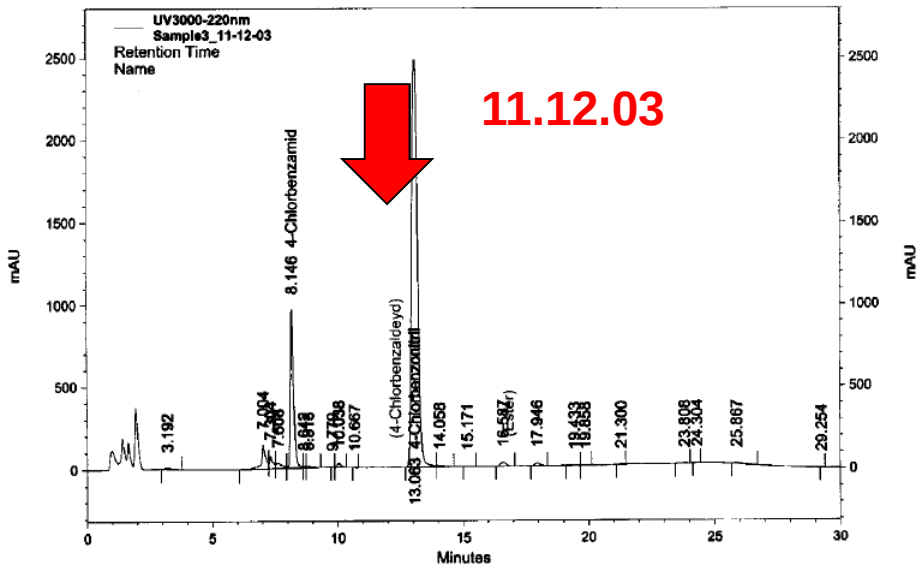
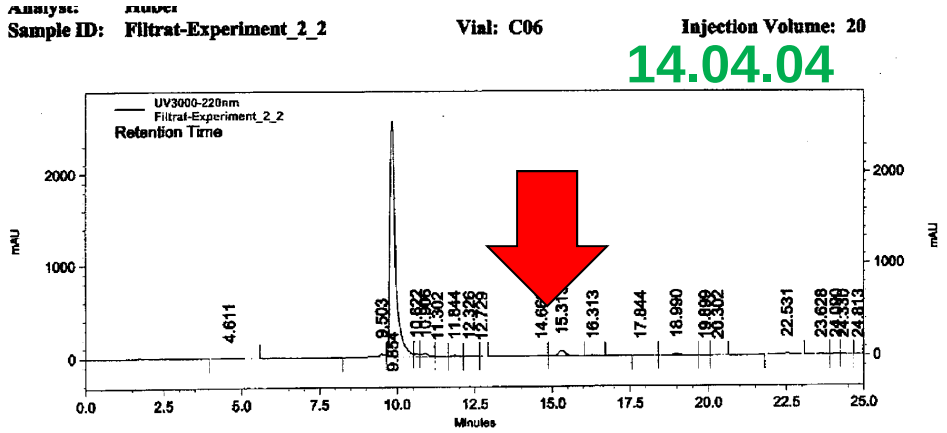


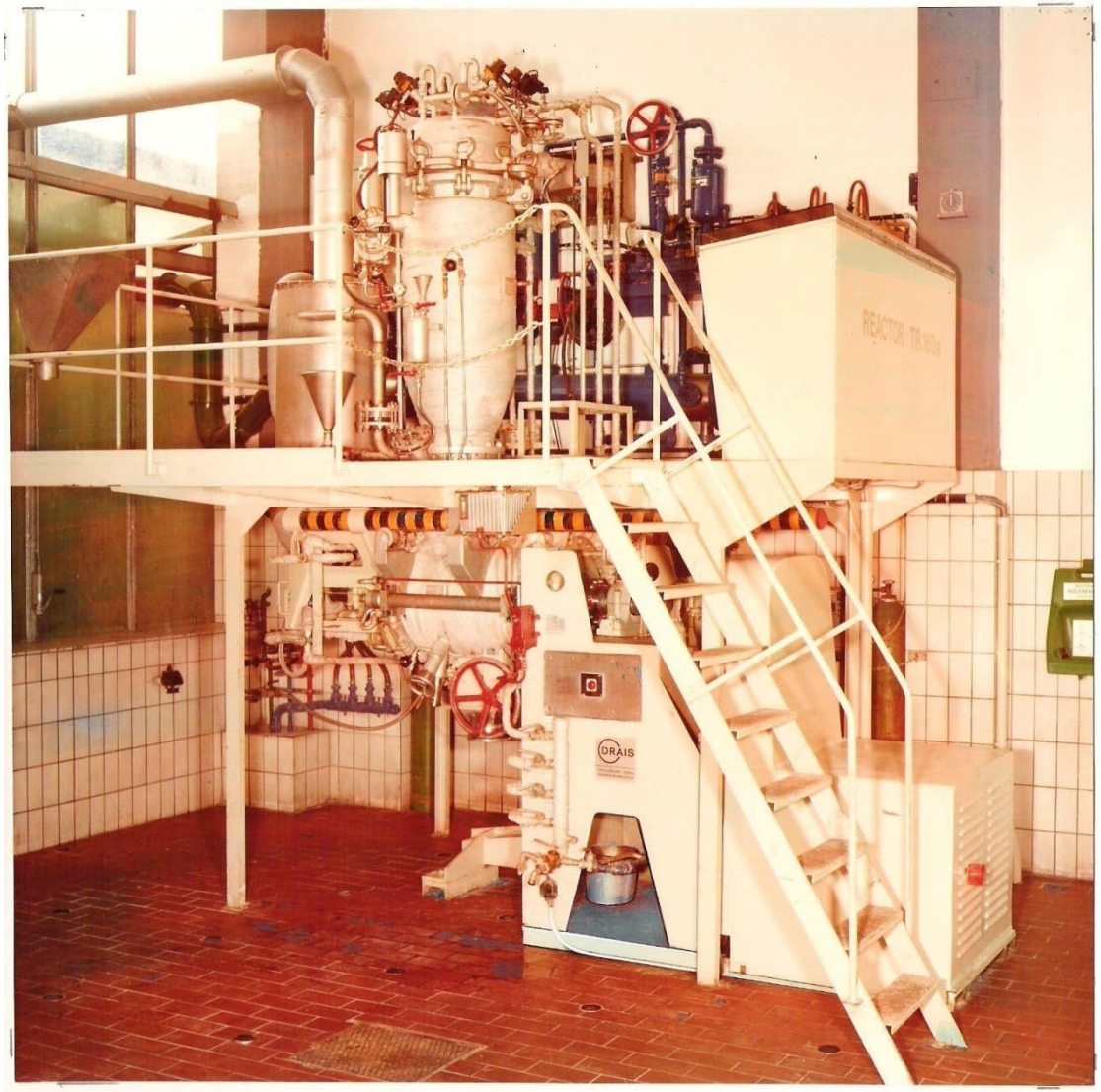






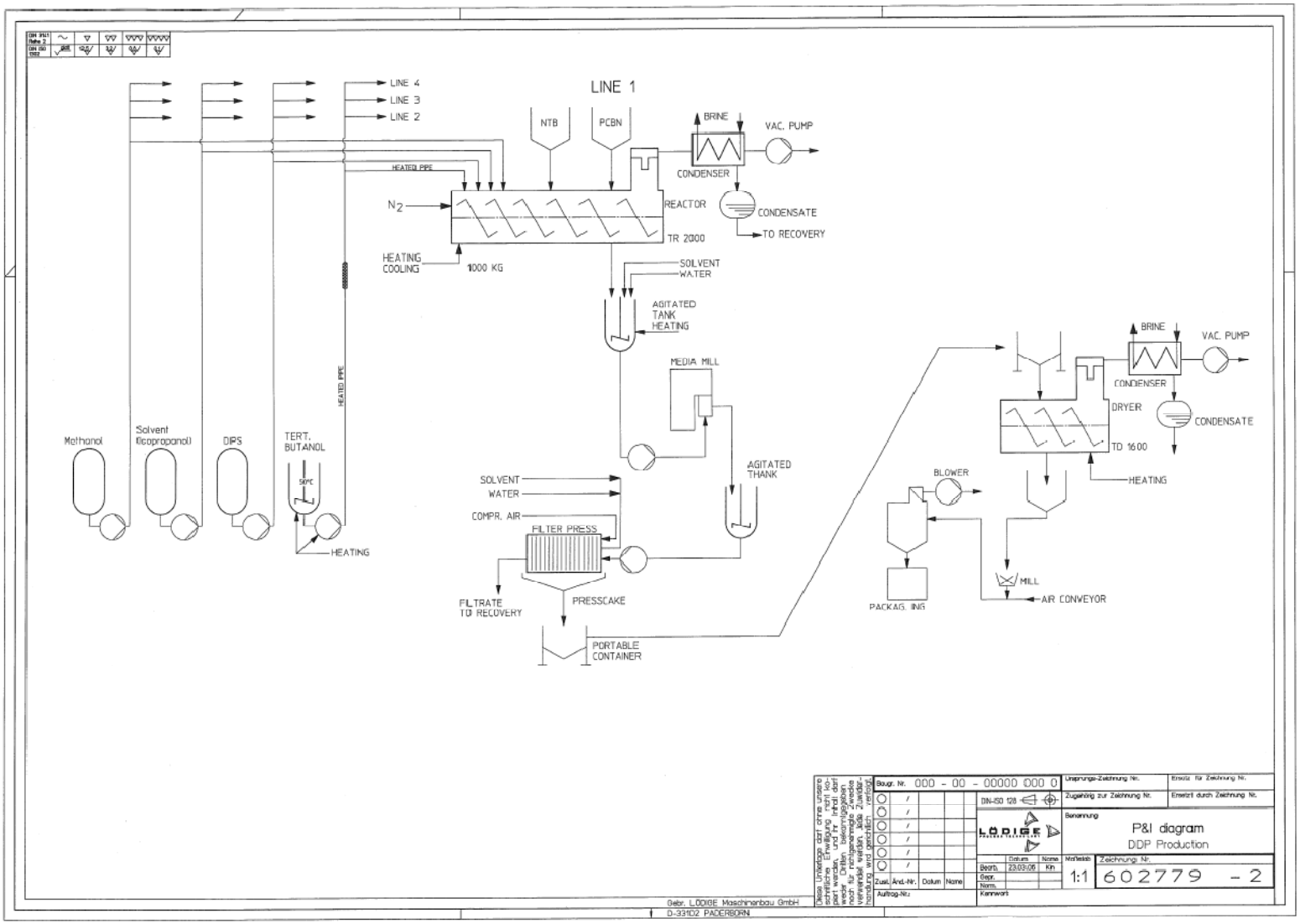
MCA DPP pigment technology: Zero-emission Pilot Plant- Germany

MCA TECHNOLOGIES GmbH (Switzerland)



MCA DPP pigment technology: production plant

MCA TECHNOLOGIES GmbH (Switzerland)



MCA DPP pigment technology : Patents

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European Patent: ***Granted***

Indian Patent: ***Granted***

Chinese Patent: ***Granted***

USA: ***Granted***

Japan: ***Pending***

Synthesis of 4-cyanobiphenyl for DPP pigments

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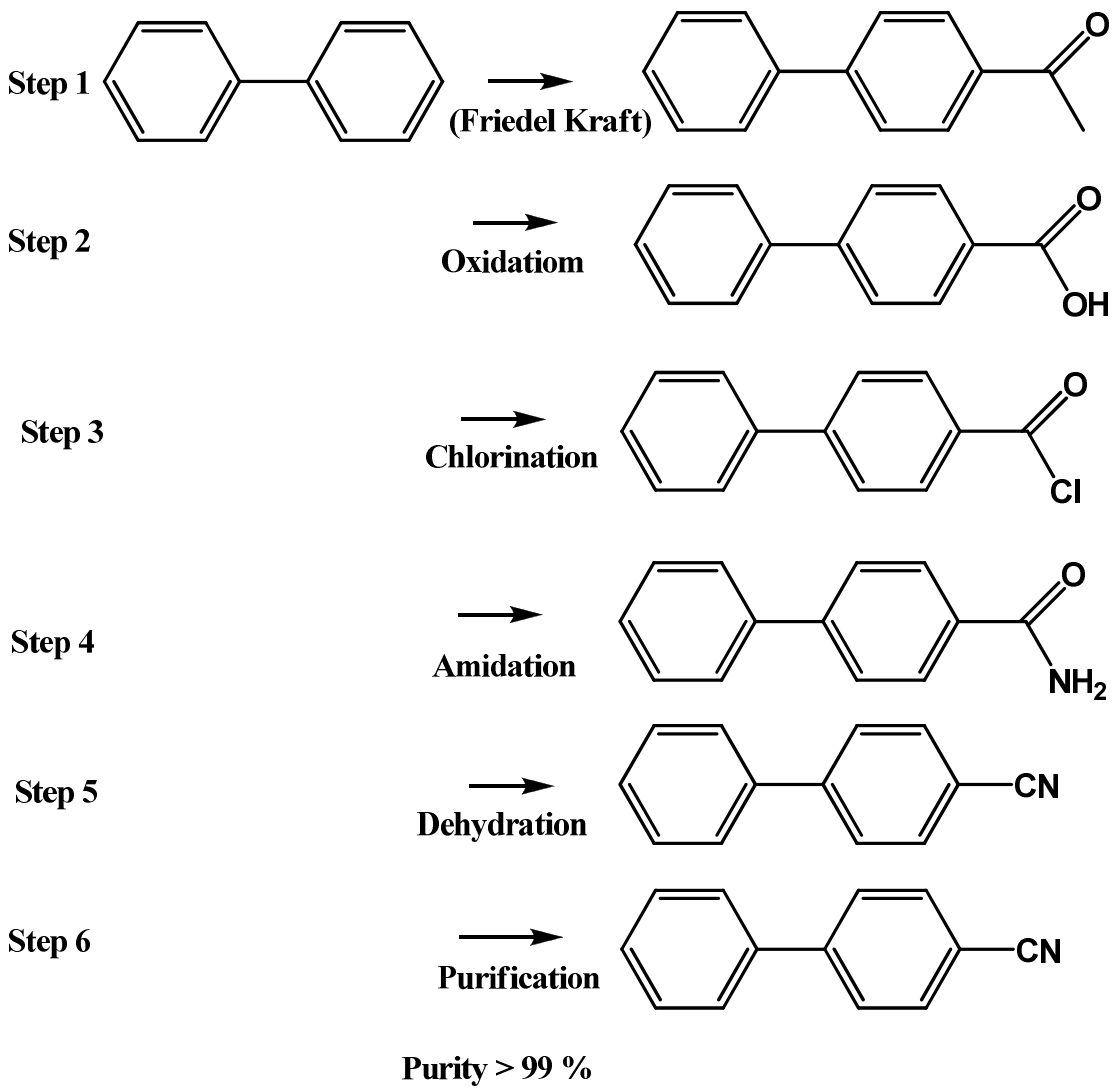

Purity > 99 %

Cyanobiphenyls as fine chemicals of the pharmaceuticals Industry

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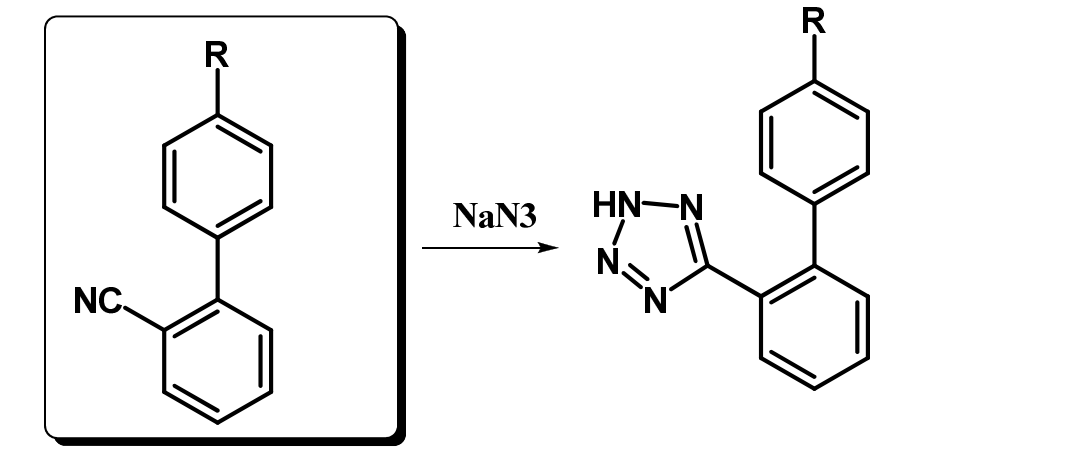
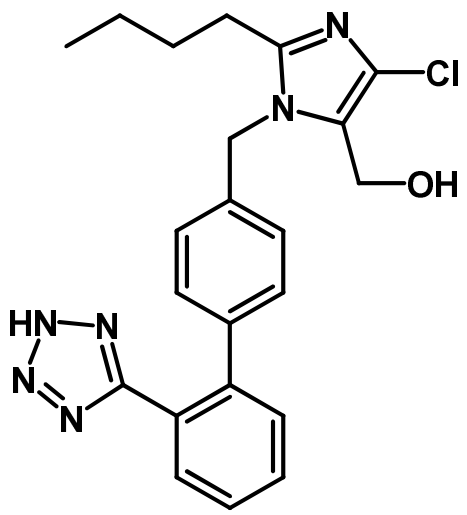
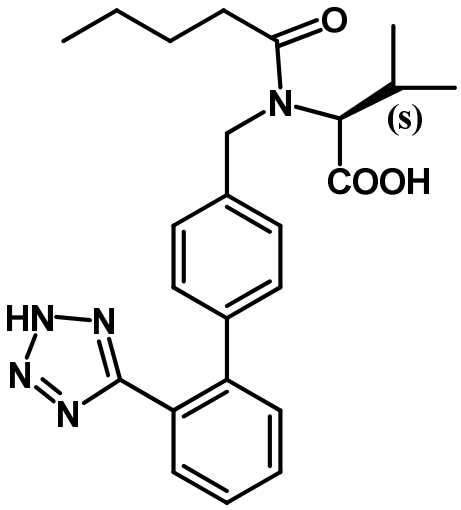




Losartan



Valsartan

Nanoparticles

What are nanoparticles?

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Definition

No accepted international definition, usually under 100 nm (1 nanometer = 0.001 micron). But generally the size at which materials display different properties to the bulk material.

What is unique about a nanoparticle?

High efficacy and effectiveness of the inherent properties, because of its high surface area.

Nanoparticles

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Applications:

Required and desired where solid materials are used in finely dispersed form, such as in drug delivery systems, cosmetics, agro chemicals, coatings, plastics, inks & textiles, only to name a few applications

Problems:

1) Difficult to disperse. And, once dispersed, they tend to re-agglomerate & reaggregate, because of their high specific surface area and energy
2) Durability & stability problems (susceptibility to light, heat , chemicals and atmosphere etc), again because of surface chemistry.

Manufacturing methods:

Made from the bulk materials, requiring lot of energy . Many also made directly as dry powders, and it is a common myth that these powders will stay in the same state , and when used .

Solutions:

Formation of regularly shaped particles

Electronics applications of semi-nanoparticle pigments for colour filters of LCDs

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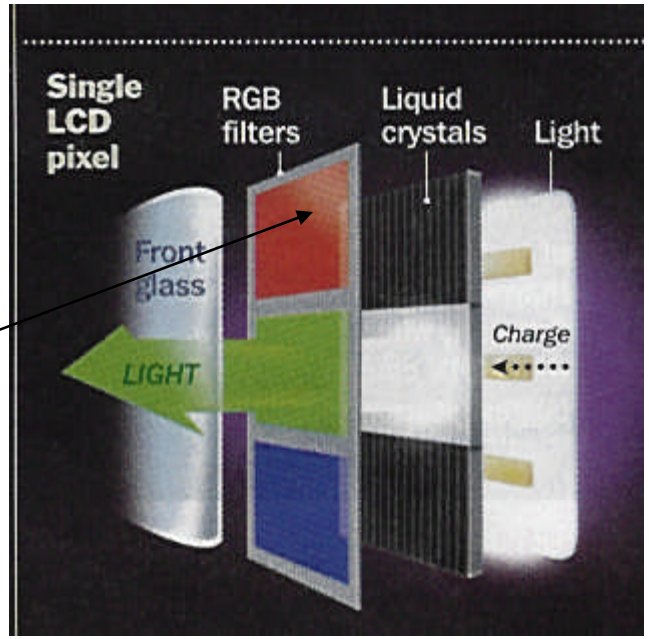

DPP

Colour filter of liquid crystal displays

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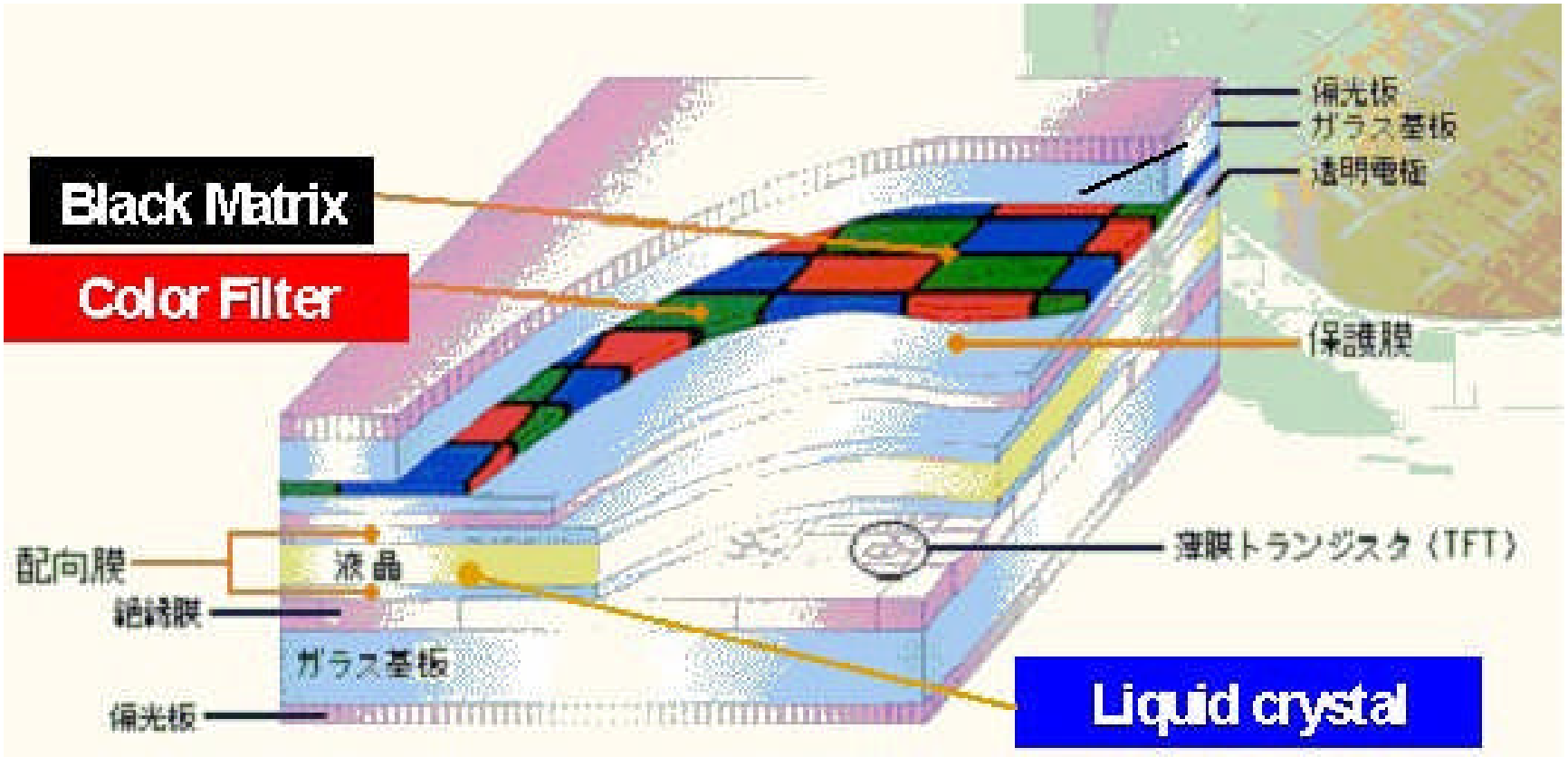

Digital colour displays and expression

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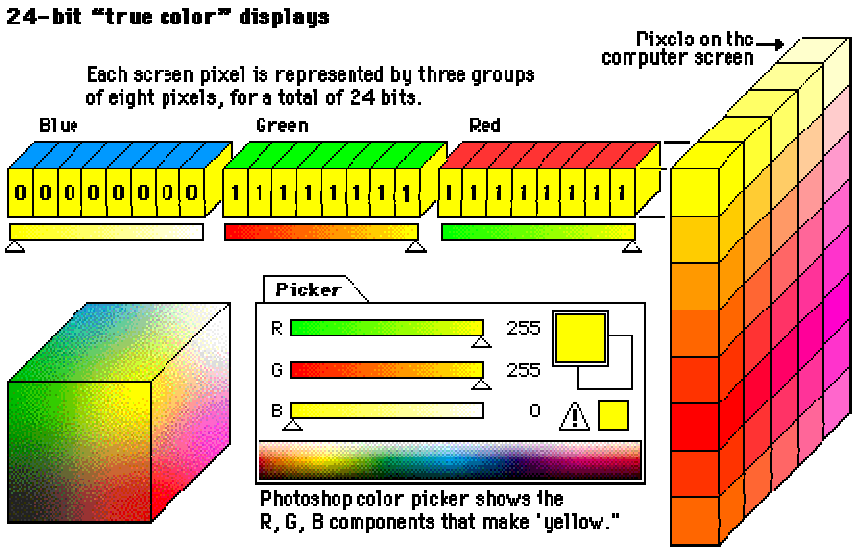
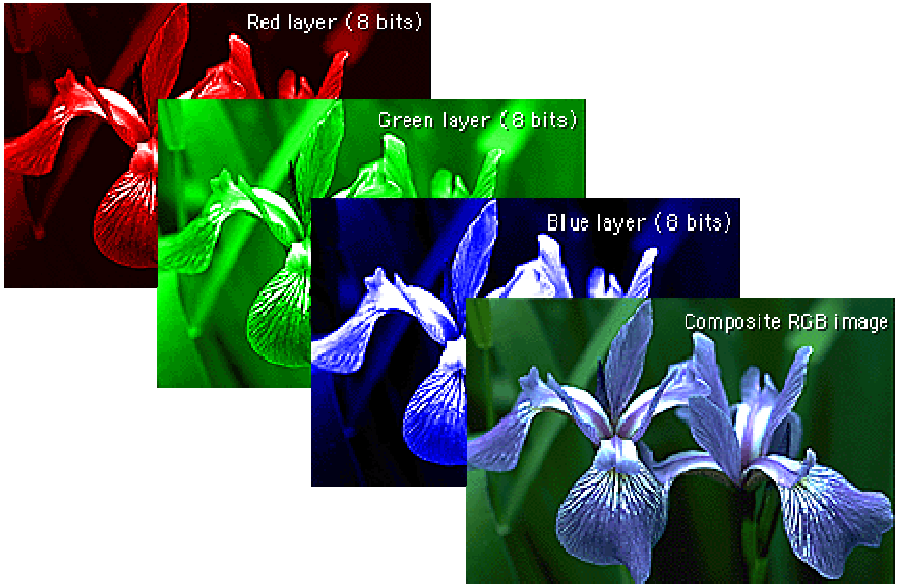


Software



Hardware

Pixel defects of LCDs

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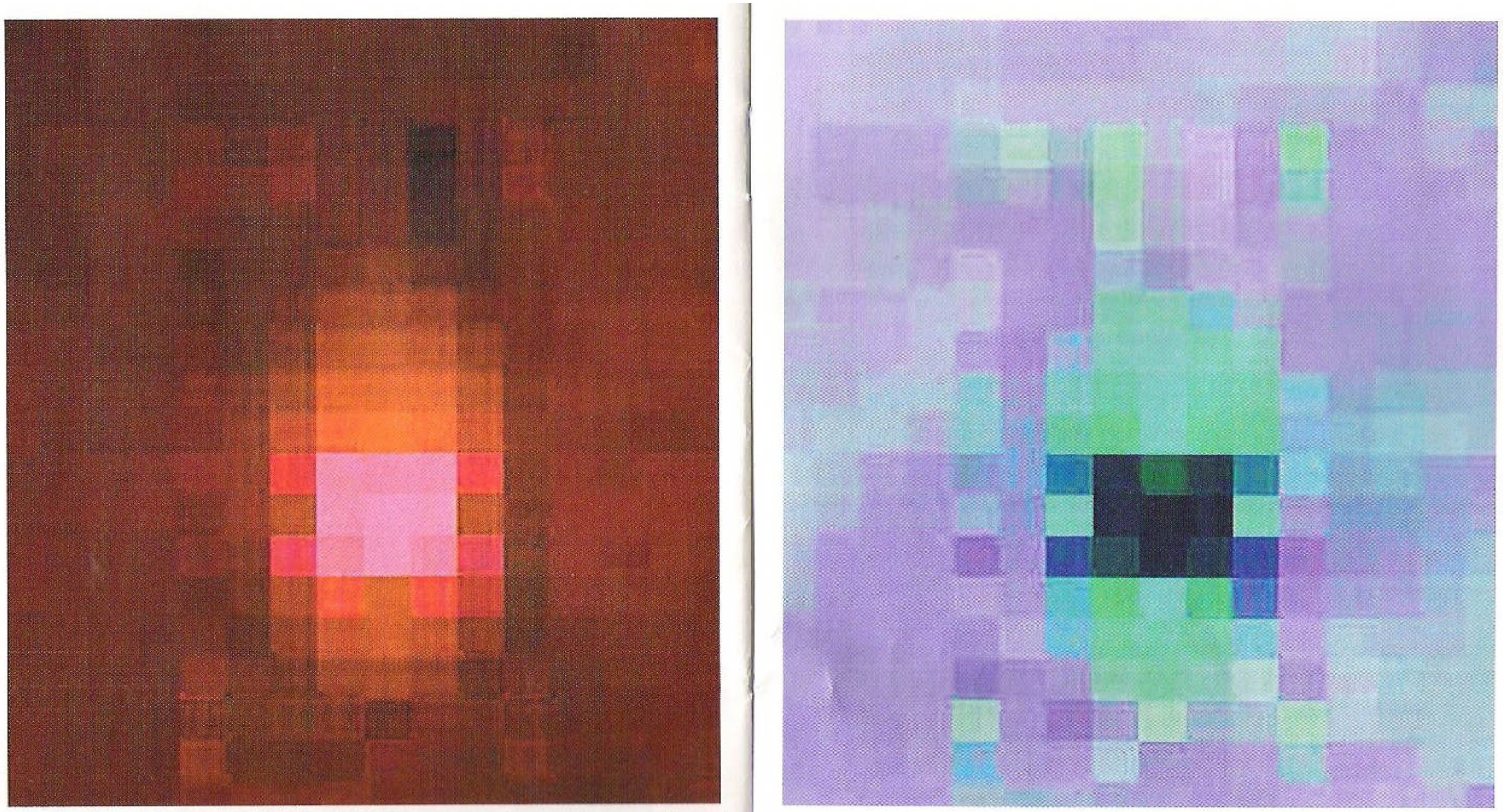

Pixelfehler: Statt gleichmässiger Pixelverteilung gibt es störende helle (linkes Bild) oder dunkle Flecken (r.)

MCA (nano)technology vs. State-of-the-art (nano)technology

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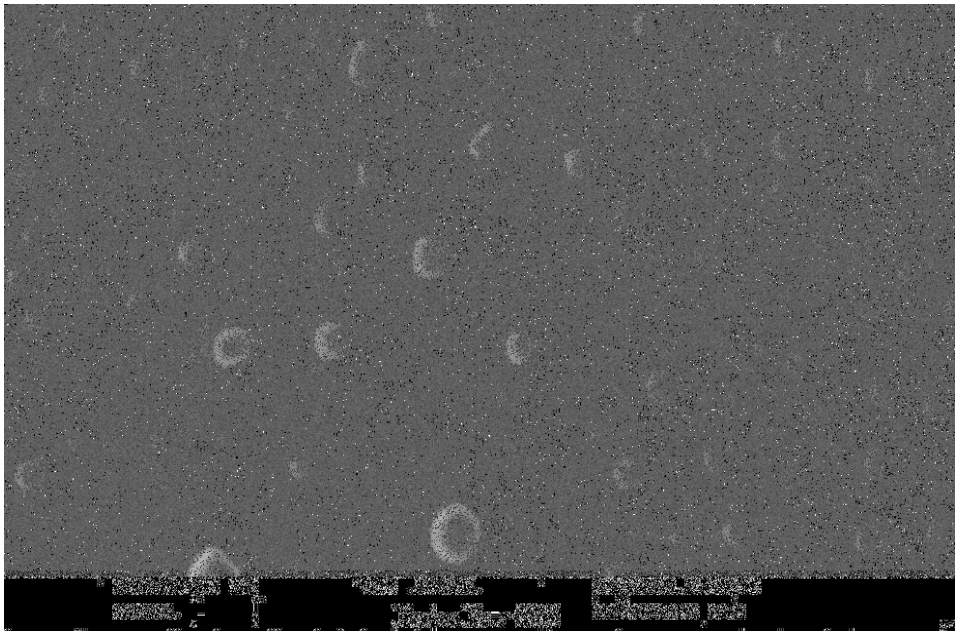
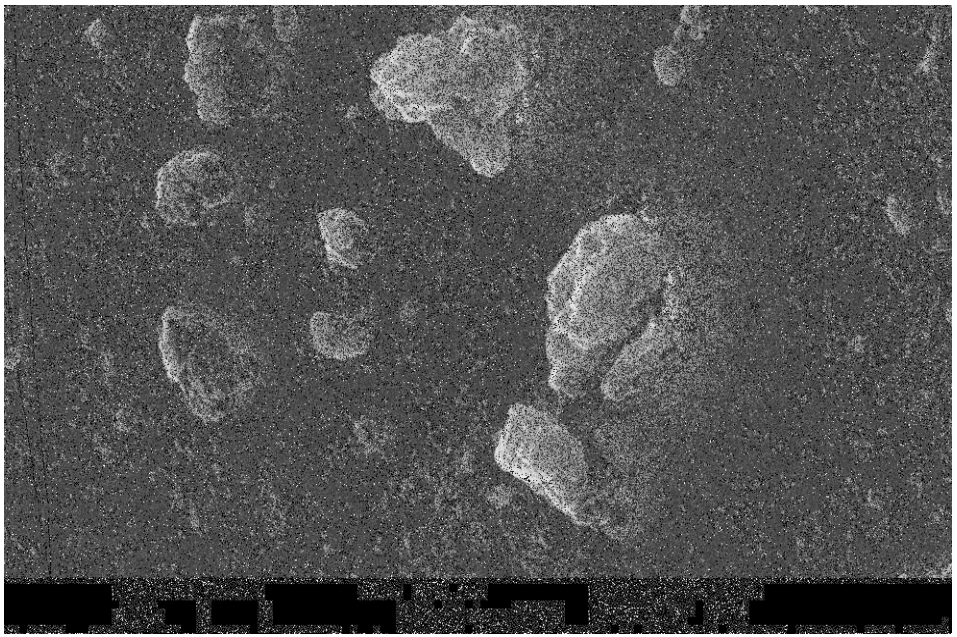
MCA DPP CF



State-of-the-art DPP CF



SEM pictures

MCA DPP pigment technology: Finishing of (DPP) pigments

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- **Specific & controlled particle size distribution for diverse applications**
- **Narrow Particle size distribution, for easy dispersibility and better coloristic properties**
- **Easy "Additivation" if and when required, for specific Applications**

Nanotechnology

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