Real-time particle size analysis during inkjet ink pigment processing

PAT4nano

PAT4nano: ***Virtual Kick Off meeting*** **27-05-2020**

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Real-time particle size analysis during inkjet ink pigment processing

Overview

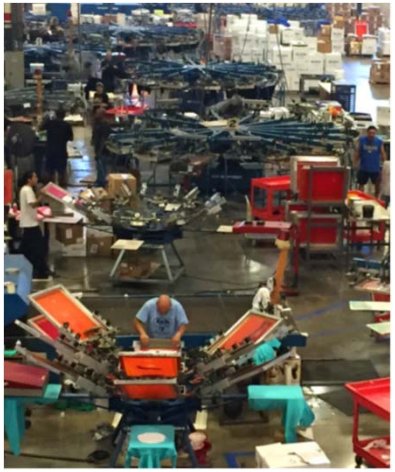
- Traditional vs Digital Industrial Printing
- Industrial Inkjet Printing
- Small pigment particles: no coincidence, but a necessity!
- How to reach the desired small pigment particles and avoid oversizers?
- QC
- PAT4nano

Real-time particle size analysis during inkjet ink pigment processing

Traditional vs Digital Industrial Printing

Traditional Industrial Printing

- Cheap for high run printing
- Expensive for short run printing
- No variable data
- A lot of stock
- A lot of waste



Digital Industrial Printing

- Short run printing not more expensive than high run printing
- Variable data possible: personalization
- Small stock because print just before use
- Less waste
- Inkjet = most ecological digital printing technique

Source: Agfa

Jeti Tauro H3300 LED

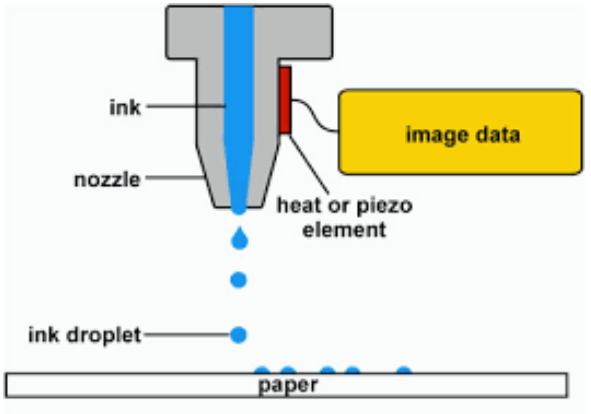
Real-time particle size analysis during inkjet ink pigment processing

Industrial Inkjet Printing

Image build-up

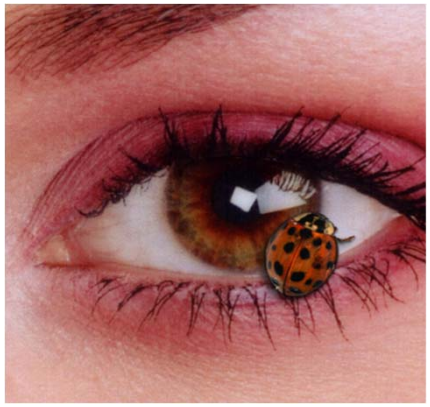
- 4-color pigment ink set: CMYK
- Ink droplets jetted on media by printhead with piezo electric element
- 1 printhead/colour
- Several printheads in an engine

Principle of Inkjet printing

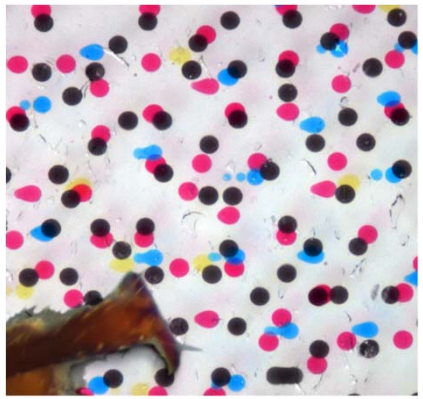


Industrial printhead

Source: Xaar



Source: Agfa



100x Source: Agfa

Ink Droplets

- Dropletsize: 10 pL (10^{-12} L)
- # droplets/m^2: +/- 1.5 billion
- +/- 15 mL ink/m^2
- Printspeed: 30.000 droplets/nozzle/sec (kHz)

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Industrial Inkjet Printing

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Size does matter!

Story of kilohertz, microseconds, nanocrystals & picoliters

Human eye

50 µm

Light Microscope

0.3-0.5 µm

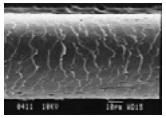
SEM

Micro world

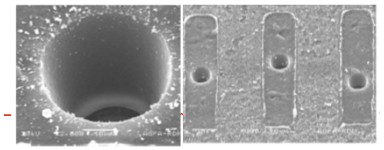
Nano world

10^{-2} m	1 cm 10 mm
10^{-3} m	1 millimeter (mm)
10^{-4} m	0.1 mm 100 µm
10^{-5} m	0.01 mm 10 µm
10^{-6} m	1 micrometer (µm)
10^{-7} m	0.1 µm 100 nm
10^{-8} m	0.01 µm 10 nm
10^{-9} m	1 nanometer (nm)
10^{-10} m	

Grain of sand
1 mm =
1000 µm



Human hair
50-100 µm



Printhead nozzle
20-50 µm

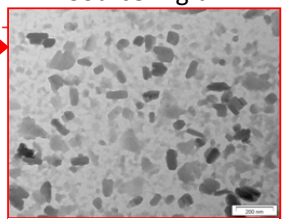
Red blood cell
3-5 µm

Protein
10 nm

Atom
0.1 nm

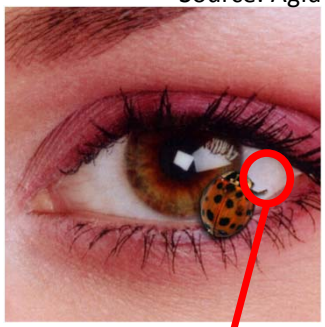
DNA
1 nm

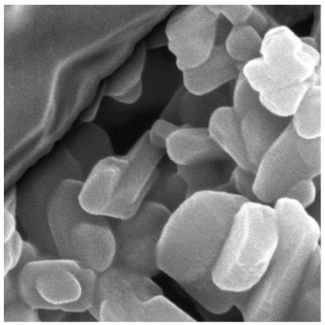
Source: Agfa



Pigments
50 -200 nm

Source: Agfa





100.000x

Source: Agfa

AGFA

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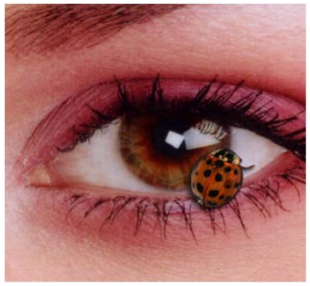
Industrial Inkjet Printing



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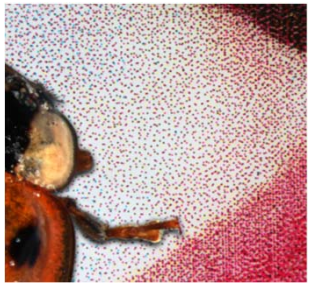

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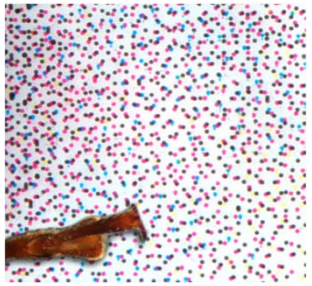
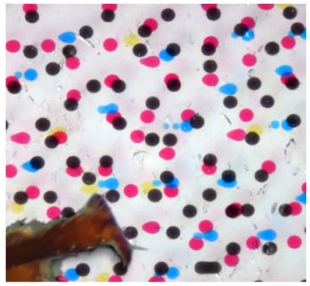
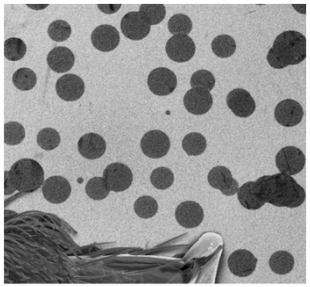


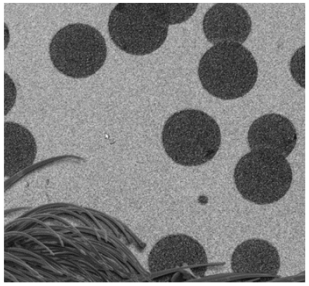
50x



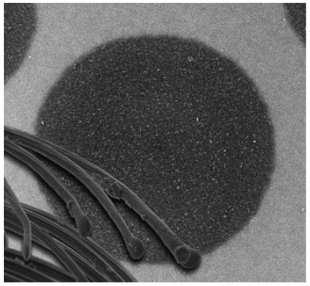
100x



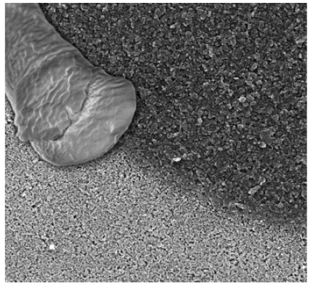
250x



500x



2000x



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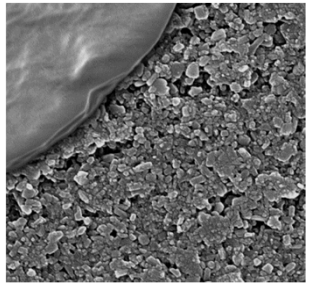

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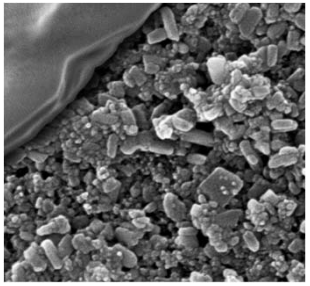

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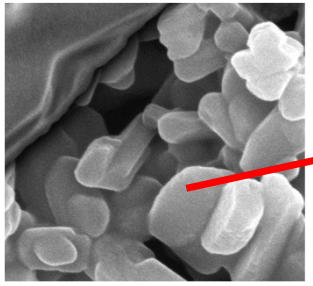
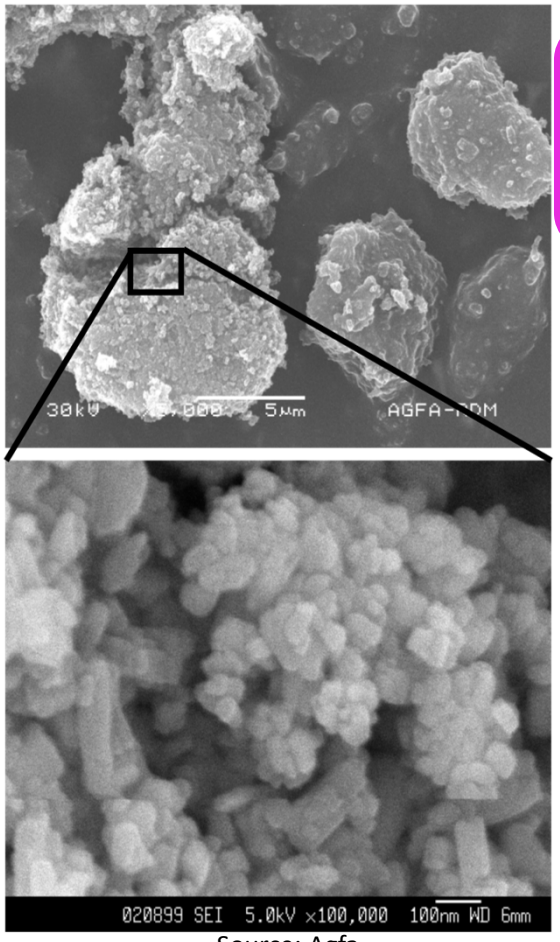


100000x

Small pigment particles!

Real-time particle size analysis during inkjet ink pigment processing

Small pigment particles: no coincidence, but a necessity!

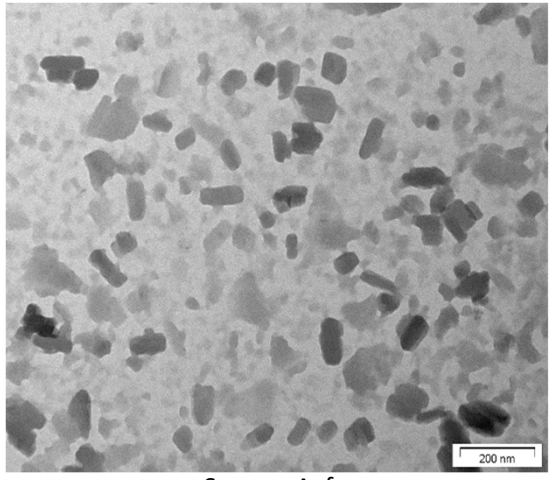


Source: Agfa

Raw Material Pigment
=
Agglomerates and Aggregates

Diminish ϕ & avoid oversizers for
- **Transparancy**
- **Colour strenght**
- **Printhead**

Inkjet Pigment Dispersion & Ink
=
Small aggregates, individual particles & no oversizers



Source: Agfa

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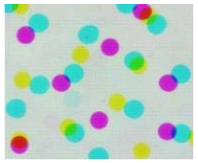
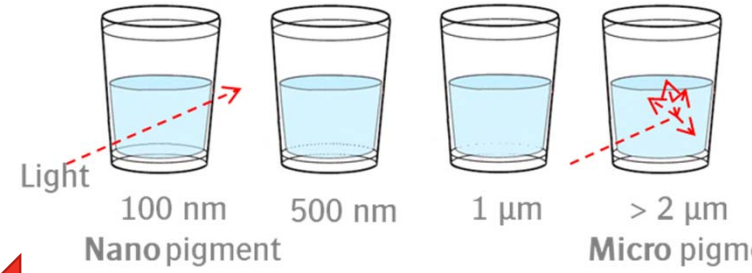
Small pigment particles: no coincidence, but a necessity!

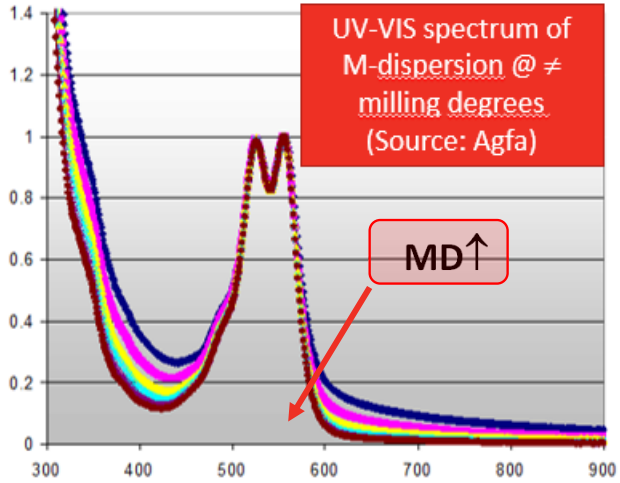
Transparancy: Image build-up!





Transparancy =
No scattering =
No oversizers

Inkjet Printing ⟷ **Transparant** … **Opaque** ⟷ **Paint**



Source: Agfa

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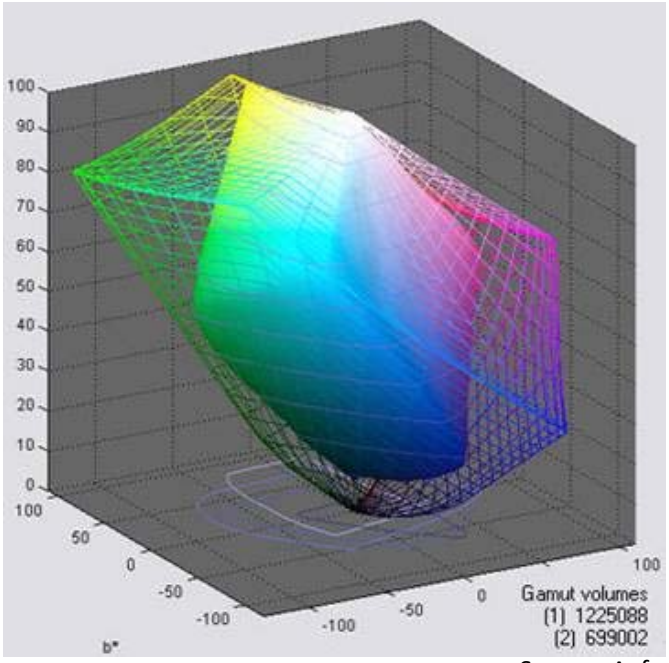
Small pigment particles: no coincidence, but a necessity!

Colour strength

- Ink consumption ↓ (€↓)
- Image quality ↑
- Colour gamut ↑



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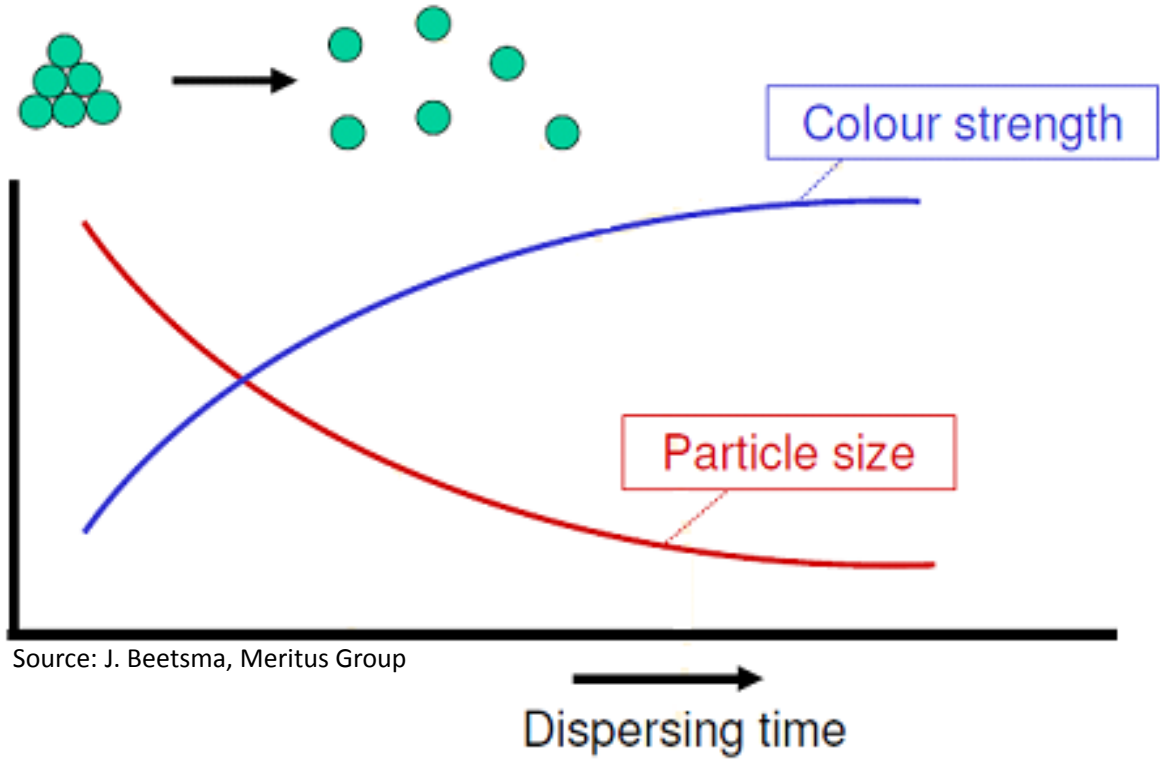

Source: J. Beetsma, Meritus Group

Real-time particle size analysis during inkjet ink pigment processing

Small pigment particles: no coincidence, but a necessity!

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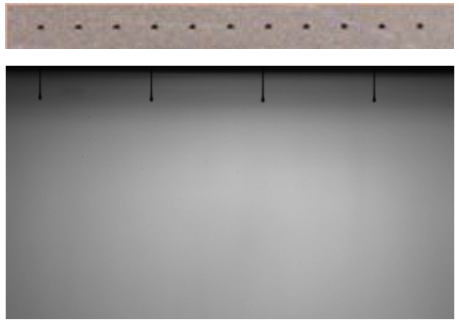
Printhead

- Normal lifespan: several years
- Expensive! ~3000 €/head
  - 6-48 heads/ printer (Agfa printers) → 18k€ - 144k€
  - Non-disposable
- If nozzle(s) is (are) blocked → costs! → Printhead + Printjob

Industrial printhead

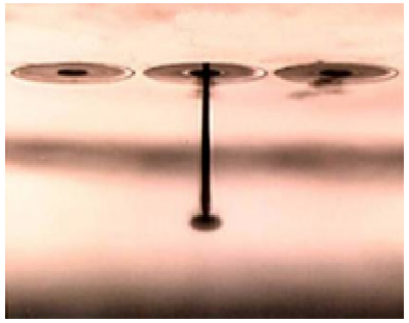
Source: Xaar

Ejection of droplets



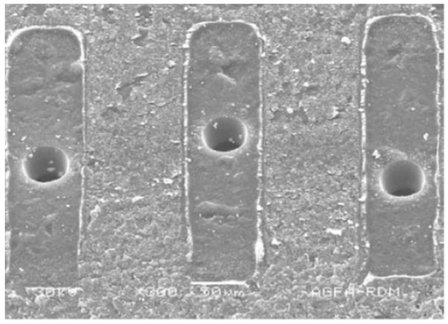
Source: Agfa

Ejection detail



Source: Agfa

Printhead nozzle detail (20-50µm)



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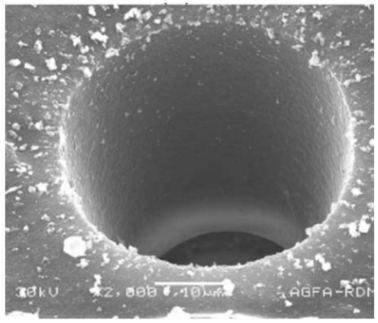

Source: Agfa

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Real-time particle size analysis during inkjet ink pigment processing

How to reach desired small pigment particles and avoid oversizers?

DISPERSION PROCESS

Formulation & Milling Process

+

INK PROCESS

Formulation & Filtration

Real-time particle size analysis during inkjet ink pigment processing

Dispersion Process

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Raw Materials → Wetting → Predispersion → Milling → Inkjet Pigment Dispersion

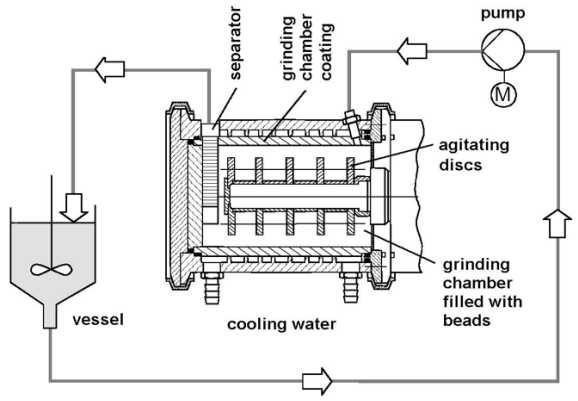
$Z_{average}$ <200nm

Monomodal, narrow PSD

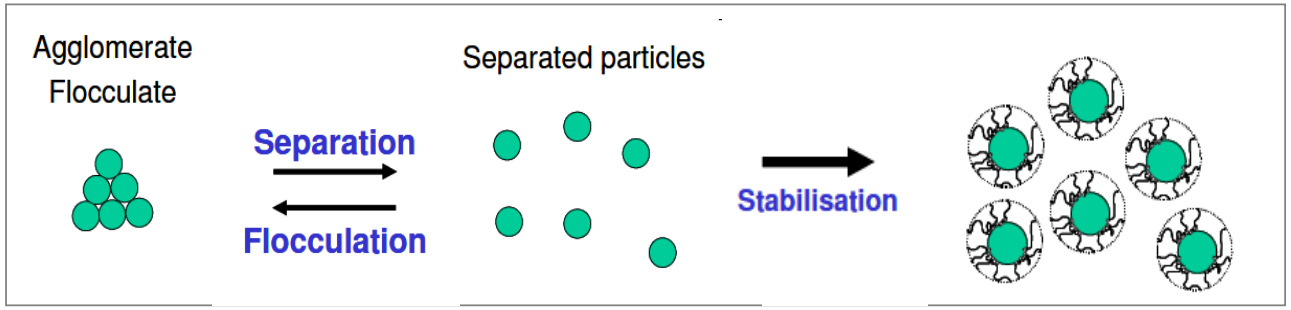
No oversizers

Seperate particles and ϕ↓

Formulation



Recirculation bead milling process



Source: J. Beetsma, Meritus Group

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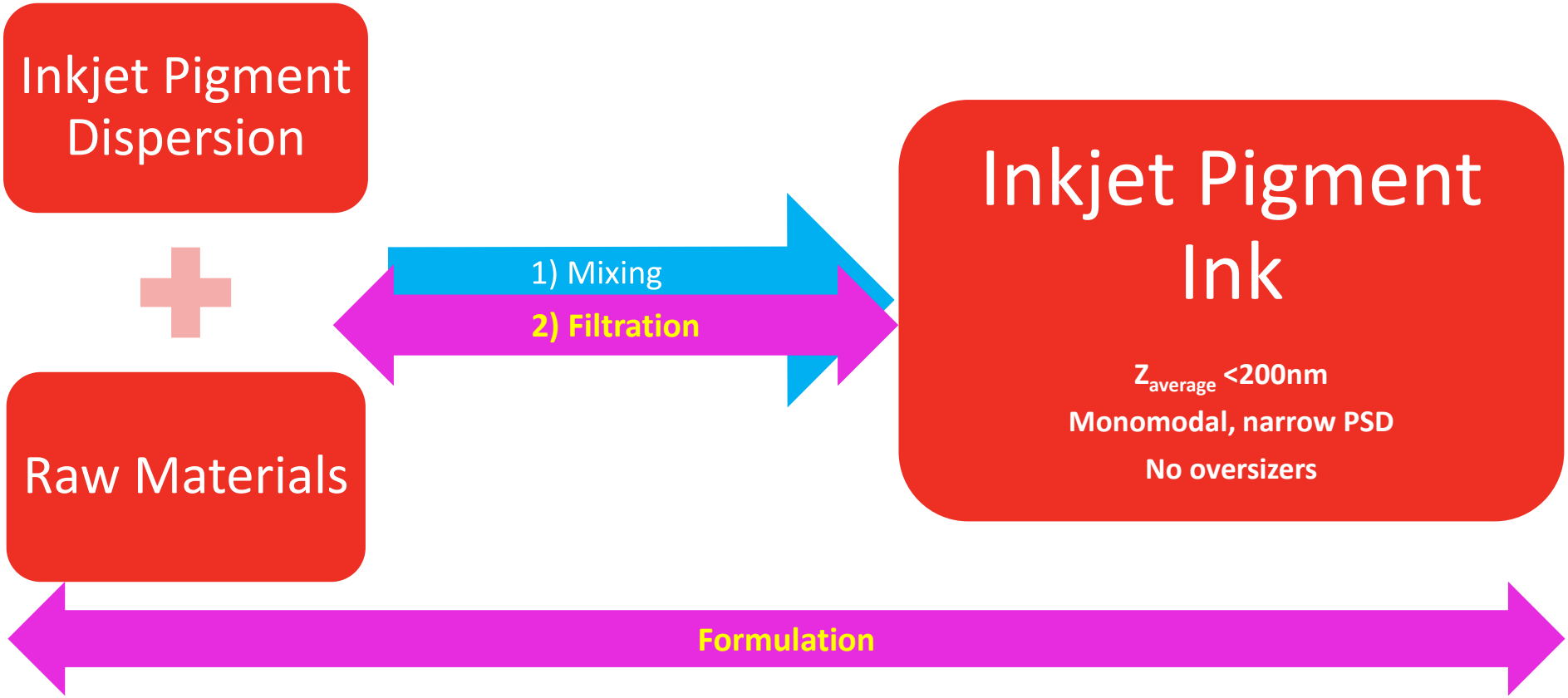
Real-time particle size analysis during inkjet ink pigment processing

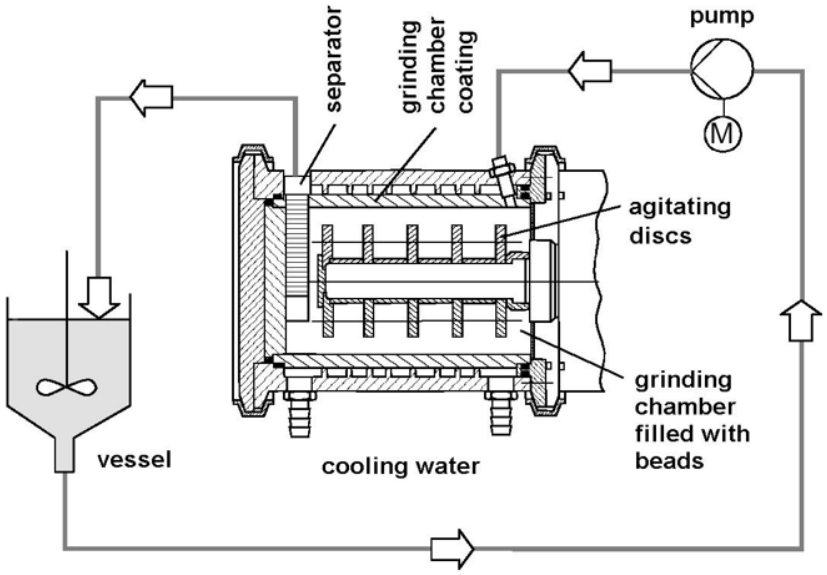
Ink Process



Real-time particle size analysis during inkjet ink pigment processing

QC

Bead milling process:
Separate particles & ϕ↓



Recirculation bead milling process

Ink process: Filtration

QC for ϕ in dispersion:
* Samples @ ≠ times during milling process
* Analyse atline
* Stop milling process when spec is reached

QC for ϕ in Ink:
* Sample after filtration
* Analyse offline
* QC passed/not passed

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