



Functional Materials Deposition Parameters & Requirements for Successful Industrial Applications

Hannah O'Brien
Alchemie Technology Ltd
Future Business Centre
Kings Hedges Road, Cambridge
hobrien@alchemietechnology.com

© Copyright - Alchemie Technology Ltd, 2017



Overview

- Opportunities and challenges for inkjet in the industrial sector
- Requirements for formulating and depositing difficult or non-graphic materials
- Key considerations for formulating reliable fluids based on difficult materials
- Recent print head and fluid technology developments that are broadening the scope for inkjet

© Copyright - Alchemie Technology Ltd, 2017



Digital technologies for the application of materials science



Jetronica technology

- Technology for selectively patterning high volume liquids or powders
- Applying functional and difficult materials (large particles, large drops)

Suite of powder dispensing solutions



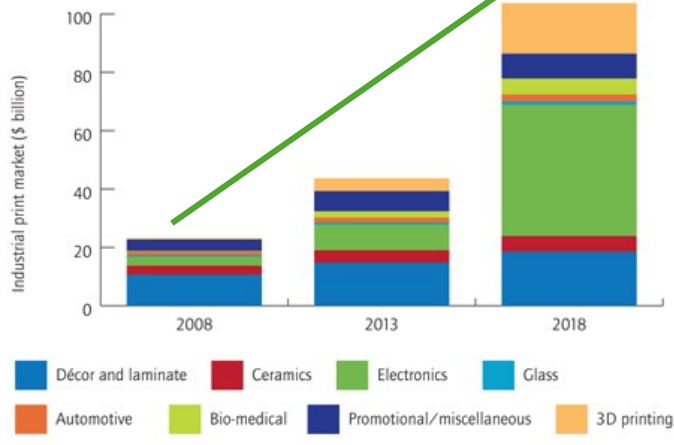
Contract development

- Developing industrial print solutions based on commercially available Trident print heads
- Chemistry led projects to develop fluids for use with industrial inkjet systems

© Copyright - Alchemie Technology Ltd, 2017



Industrial digital print growth by sector



Source;SmithersPira

© Copyright - Alchemie Technology Ltd, 2017

Ink jet opportunities are increasing

Ink jet offers key benefits:

- Increased efficiency and reduced production costs
- Just in time customization
- Fast response to customer – “print on demand”
- Zero set-up costs: economical short runs
- Increased productivity
- Reduced inventory
- Ideal for all types of substrates – rigid/flexible, flat/non-flat
- Applicable to key applications

© Copyright - Alchemie Technology Ltd, 2017

Applications driving material development

- Range of applications for inkjet is breathtaking
 - From guns to kidneys and bladders
 - From electronic devices to edible products
 - From biomedical and drug dispensing to best before coding
 - From desktop printing to ceramic tiles
 - From textiles to photovoltaics
- Creates a huge expectation and a powerful proposition
- All different applications require different materials
- Inkjet requirements for all these materials are similar

© Copyright - Alchemie Technology Ltd, 2017

Industrial applications use 'difficult' materials

- Non Newtonian
- Large particle sizes
- Agglomeration and settling
- High viscosity
- High solids loading
- Usually formulated for analogue print processes

© Copyright - Alchemie Technology Ltd, 2017

Inkjet Ink Formulations

Ingredients

Liquid carriers

- water, solvents, oils

✓ jet performance

Binders

- polymers

✓ Reliability

Colorants

- dyes & pigments

✓ Stability

Additives

- surfactants
- conductivity salts

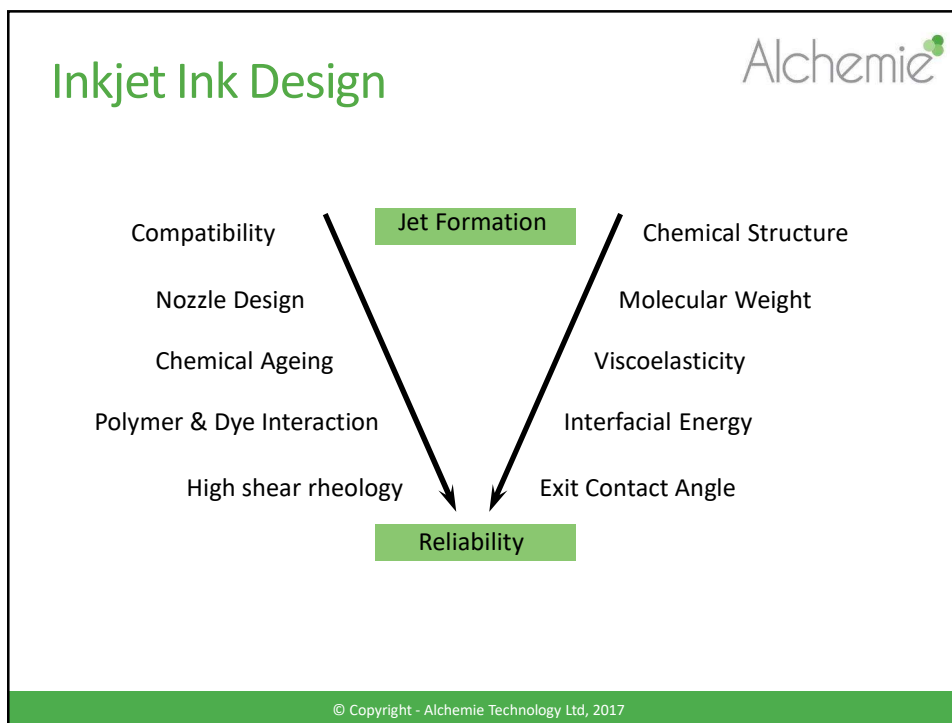
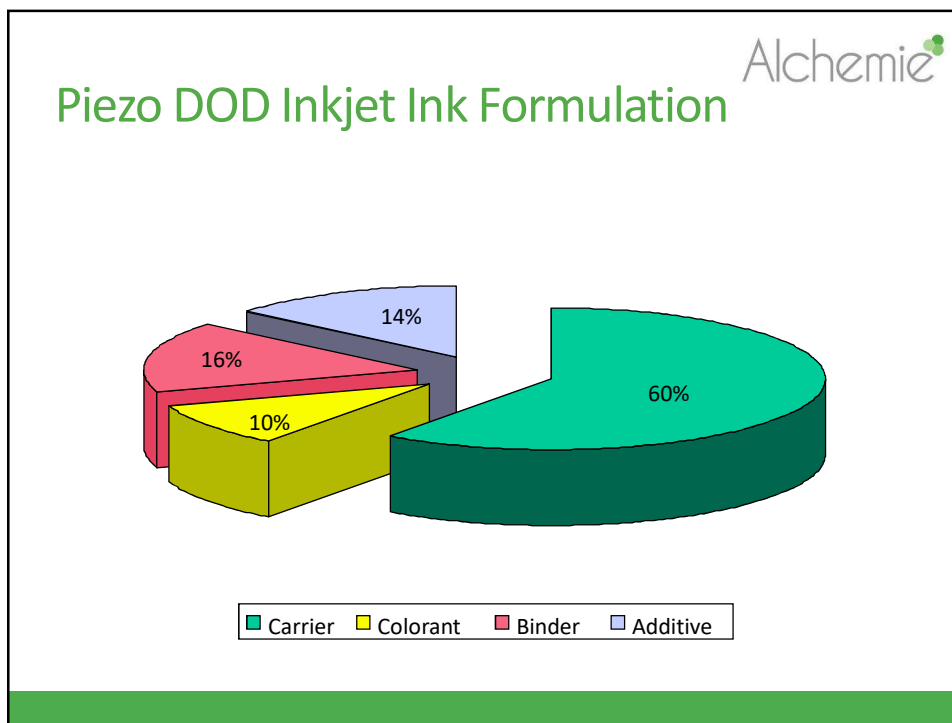
✓ application performance

Critical Materials

- Colorants
- Binders



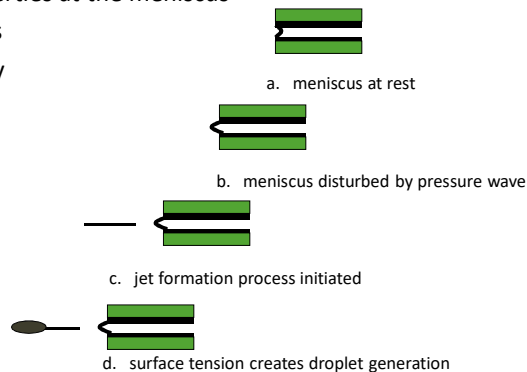
© Copyright - Alchemie Technology Ltd, 2017



Understanding the inkjet printing process

Managing an ink through print head engineering

- Microfluidic properties along fine capillary channels
- Maintaining ink properties at the meniscus
- Formation of droplets
- Consistent jet stability



Pigments

- Wide range of pigments used today
 - Organic pigments used widely in desktop and wide format applications
 - Inorganic pigments notably ceramic, lanthanides and metallic oxides
- Trend towards larger particle sizes to achieve application performance
- Understanding pigment surface chemistry is the fundamental property
- Dispersant Chemistry chosen based on size, density and type of pigment
 - Large dense inorganic particles dispersed to encourage settling and flocculation
 - Small organic pigments dispersed to produce long life homogeneous suspensions
- High surface increases stability in the dispersion but complicates wetting process

Dispersion materials

Alchemie

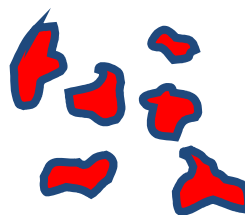
- Dispersing agent plays a vital role
- Selection of dispersant chemistry can dramatically affect pigment properties
- Dispersants stabilise pigments
- Provide efficiency by reducing viscosity
- Allows higher mill-base pigment loadings
- Create long term viscosity and colour stability (and other properties)
- Prevent shock and compatibility upon letdown of dispersions
- Determine environmental properties and VOC's

© Copyright - Alchemie Technology Ltd, 2017

Dispersion objective

Alchemie

- Primary objective is to break up agglomerates
- Create individual primary particles suspended in the carrier
- Produce stabilised particles
- Wet particle surface with dispersant
- Create a molecular dispersed layer
- Prevents any re-agglomeration
 - Improves ageing stability
 - Creates consistent jet stability



© Copyright - Alchemie Technology Ltd, 2017

Ceramics - an inkjet success story

- Highly challenging chemistry
 - Achieve sufficient pigment on printed surface to create colour density
 - Withstand high temperature firing process
 - Managing sand in water – highly abrasive
- Success based on a combination of:
 - Pigment dispersion technology advances
 - Flow through print heads
 - Recirculating ink systems
- Now an analog industry converted to digital printing
 - 8000+ printers installed globally working reliably

© Copyright - Alchemie Technology Ltd, 2017

A decade of technology advances

- Print heads
 - Greyscale heads
 - Recirculating heads
 - High speed and high resolution
 - High accuracy materials deposition
- Ink technology
 - UV-cure chemistry
 - Pigment dispersions
 - Carrier innovations - latex, aqueous UV cure
- Ink systems
 - Recirculation to control settling pigments
 - Managing reliability
- Motion control
 - Match the accuracy of the print head
- Software
 - Full image pipeline and workflow

© Copyright - Alchemie Technology Ltd, 2017

Print head trends

- Last decade print head trend has been towards smaller drops & higher resolution.
 - This has been driven by graphics applications.
 - Not helpful for emerging industrial applications involving difficult materials
- Digital technologies now trending away from graphics heritage
 - Aim to deliver truly industrial solutions for additive manufacturing applications
- Recently, announcements for larger drop volume print heads have been made
- Reinforced by success in key applications of ceramics & textiles.
 - Confidence to be robust for additive manufacturing industrial solution
- A new wave of innovation
 - to broaden the technology landscape for digital solutions

© Copyright - Alchemie Technology Ltd, 2017

Print head developments

- Xaar 1003 GS40
 - Offering drop sizes up to 160pl
 - UV and oil based inks
 - Well suited to sport varnish & printing textured effects
 - Native resolution 360npi
- TTP Vista print head
 - Ability to print particles in 50um+range
 - Flexo & gravure paints
- Archipelago technology

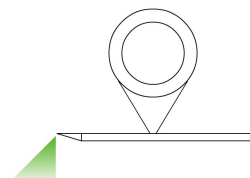


© Copyright - Alchemie Technology Ltd, 2017

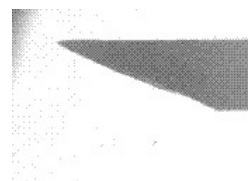
Alchemie - Jetronica

- Based on a “piezoneedle” construction
- Piezo drives pressure wave along channel
- Pressure wave is amplified at the tip
- Produces drops with high momentum
 - Large throw distances
 - Variable drop volume
 - High speed
- Jetting assembly stacked to create an array
 - Industrial resolution

Alchemie



Jetting Assembly



Jetronica