Stability Properties of Electrically Conductive Ink, Filled Metallic Nano Size Silver Filler for Ink Jet Printing Technique.

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The Major Ink Requirements for Ink Jet Dispenser Technique

DISPENSING POSSIBILITIES AND LIMITATIONS:

Single drop volume: ***30 – 500*** *picoliters with variation ~* ***1%***
Droplet diameter: ***30 – 100*** *µm*
Drop rate: ***0 – 2000****/sec.*
Fluid viscosity range: ***0.5 ~ 35*** *mPas. (unheated)*
Drop acceleration: 100 000 g (during each shoot)

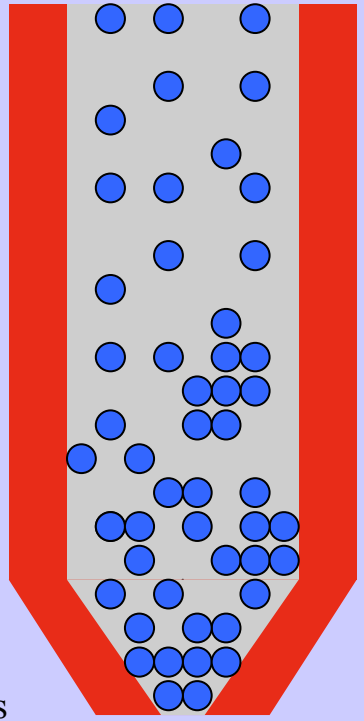
Number of components	**One**
Consistency	**Very low viscous fluid**
Percentage of silver filler	**40 - 60 %**
Viscosity limit	**Up to 35 mPas**
Thixoprophy index	**~ 1.0**
Surface tension value	**28.5 - 34 dynes/cm**
Specific gravity	**1.3 - 1.6 g/cm³**
Electrical conductivity	**(1 – 3) 10^{-5} Ωcm**

Metalic Nano Silver as a Filler for Ink Preparation

All formulation types which are the mixtures of fluid binder and solid fillers will have this same major problem - filler sedimentation.

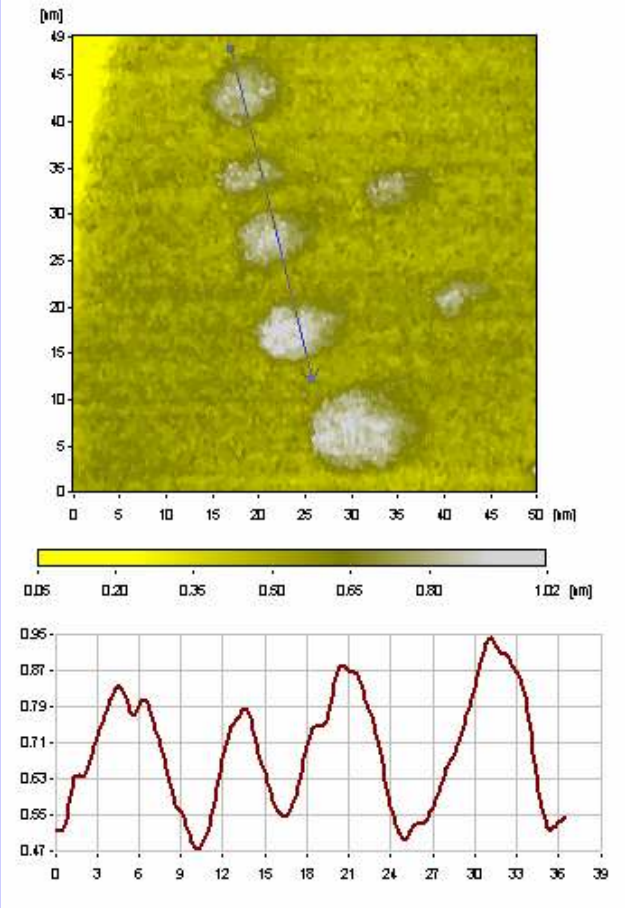
Very low binder viscosity plus:

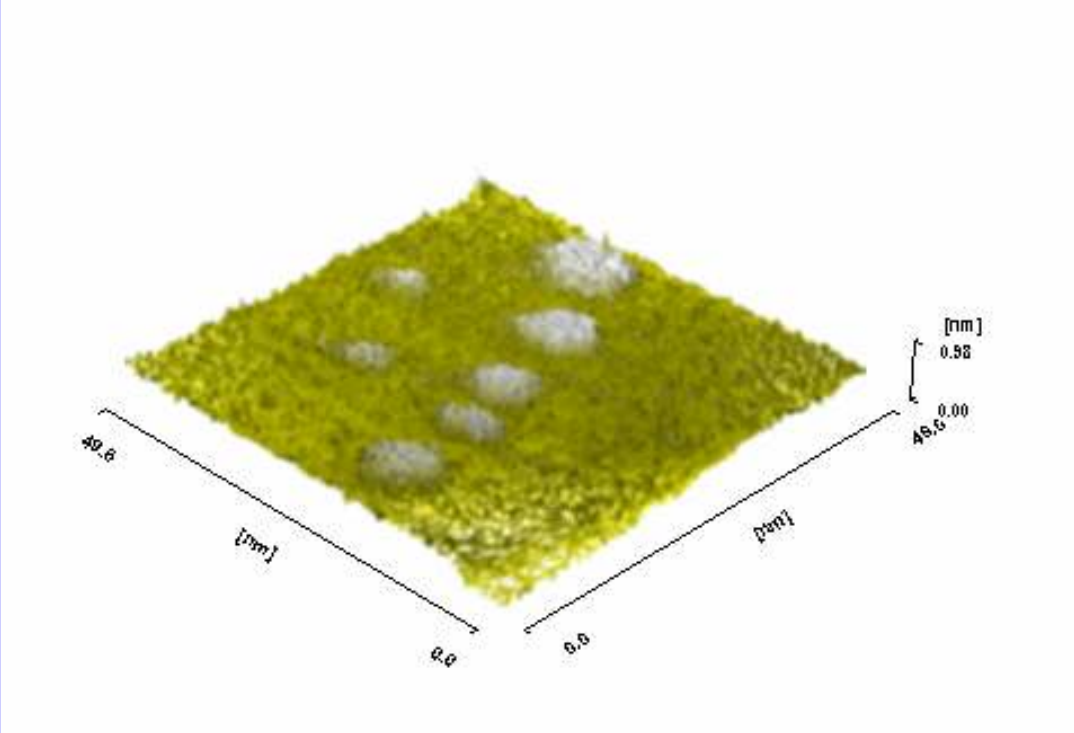
- filler which has much higher specific gravity as fluid binder,
- high % of filler inside formula



Metalic Nano Silver as a Filler for Ink Preparation

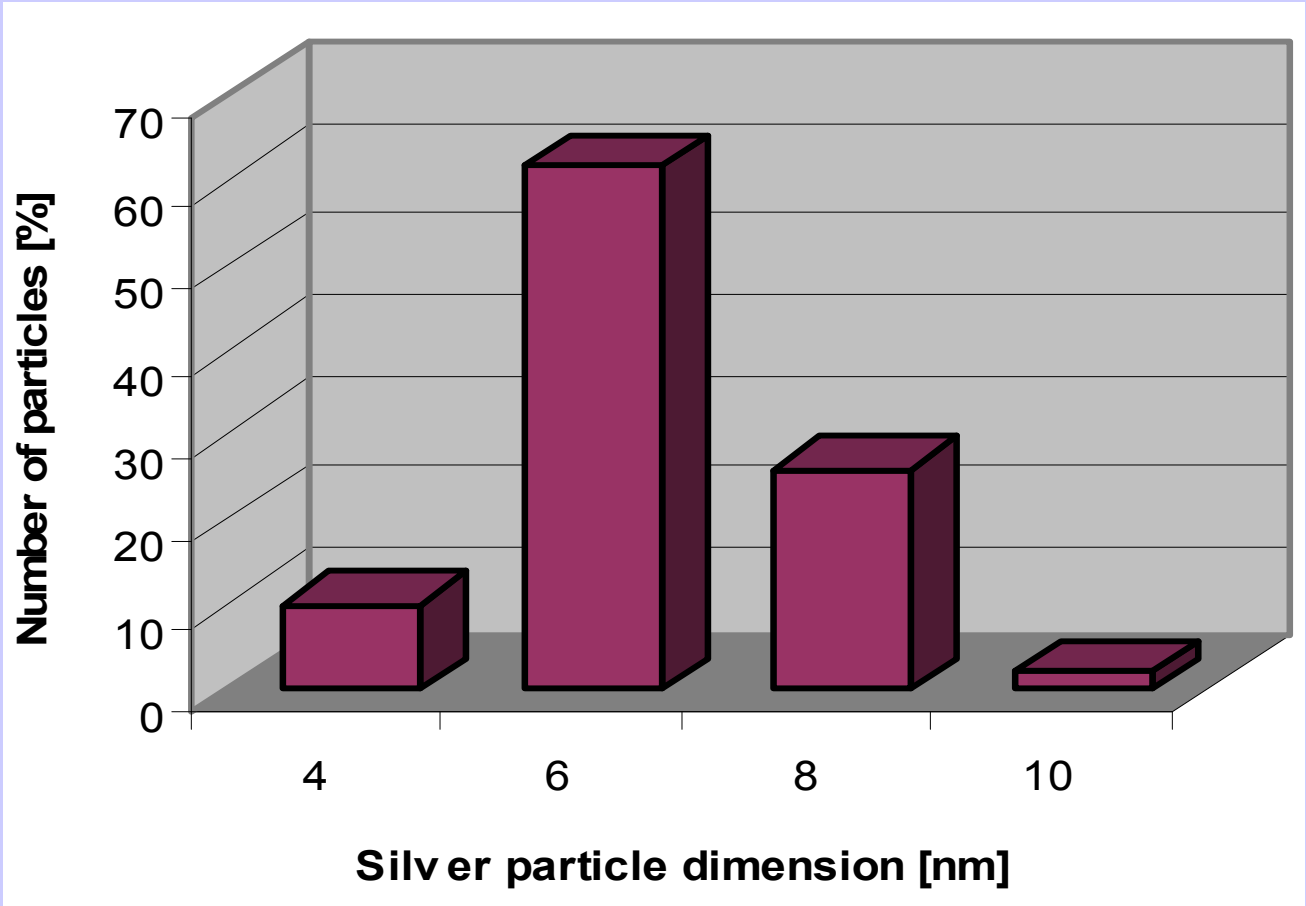
Different situation is when conductive filler has diameter less 10 nm. Than formulation is very uniform and has properties similar as a „true fluid”.





Metalic Nano Silver as a Filler for Ink Preparation

Histogram for particles size ofAmepox nano Ag



Nano Ink Stability Tests

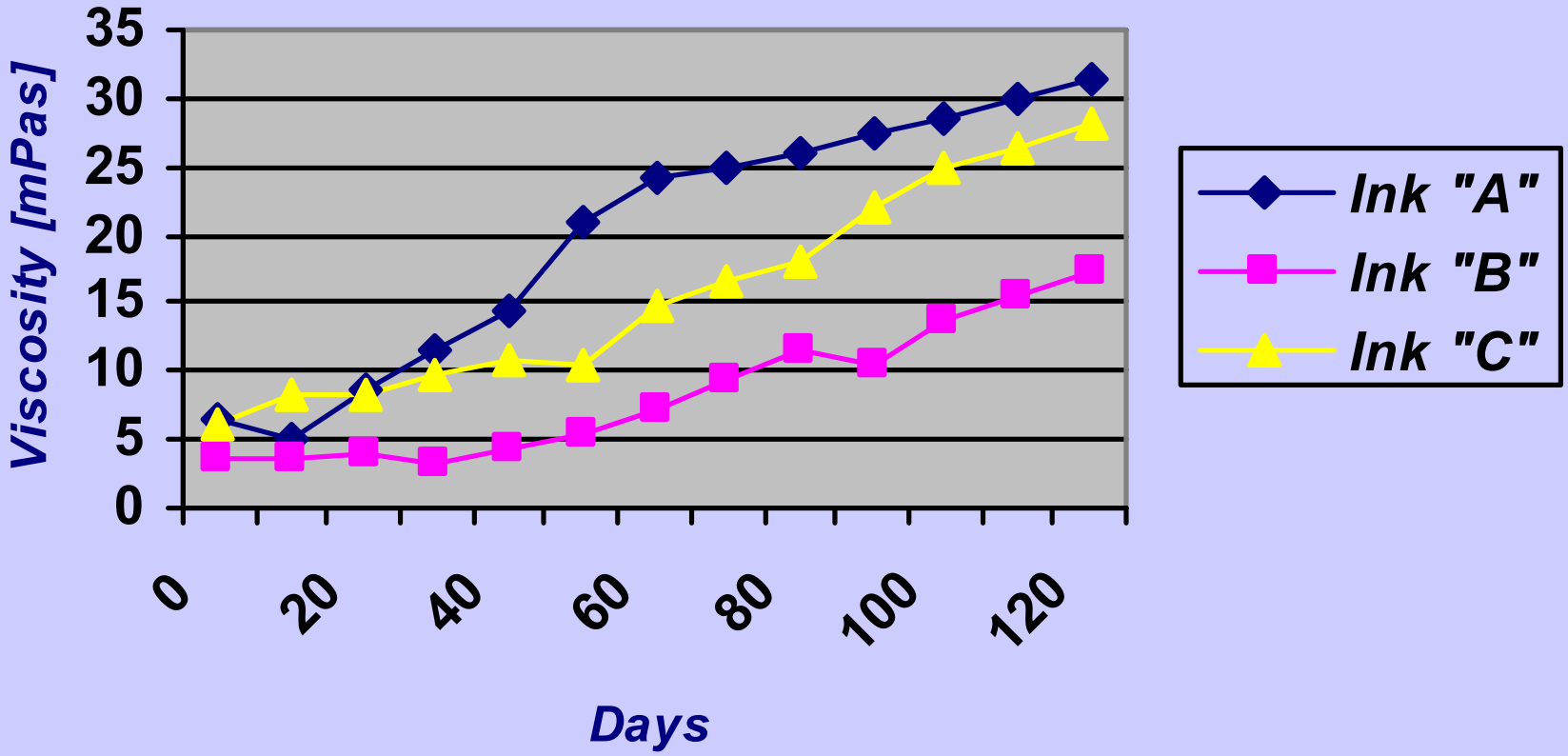
TEST CONDITIONS:

1. Equipment: Brookfield type LVDVII + CP (Cone & Plate)
2. Rotor (Cone) speed: 100 rpm
3. Storage temp. = 23°C
4. Test temp. = 25°C

Sample #	Ink A	Ink B	Ink C
Percentage of nAg [b.w.]	50%	48%	50%
Initial Viscosity [mPas]	6.5	3.66	6.1
Thixoprophy index	~1.0	~1.0	~1.0

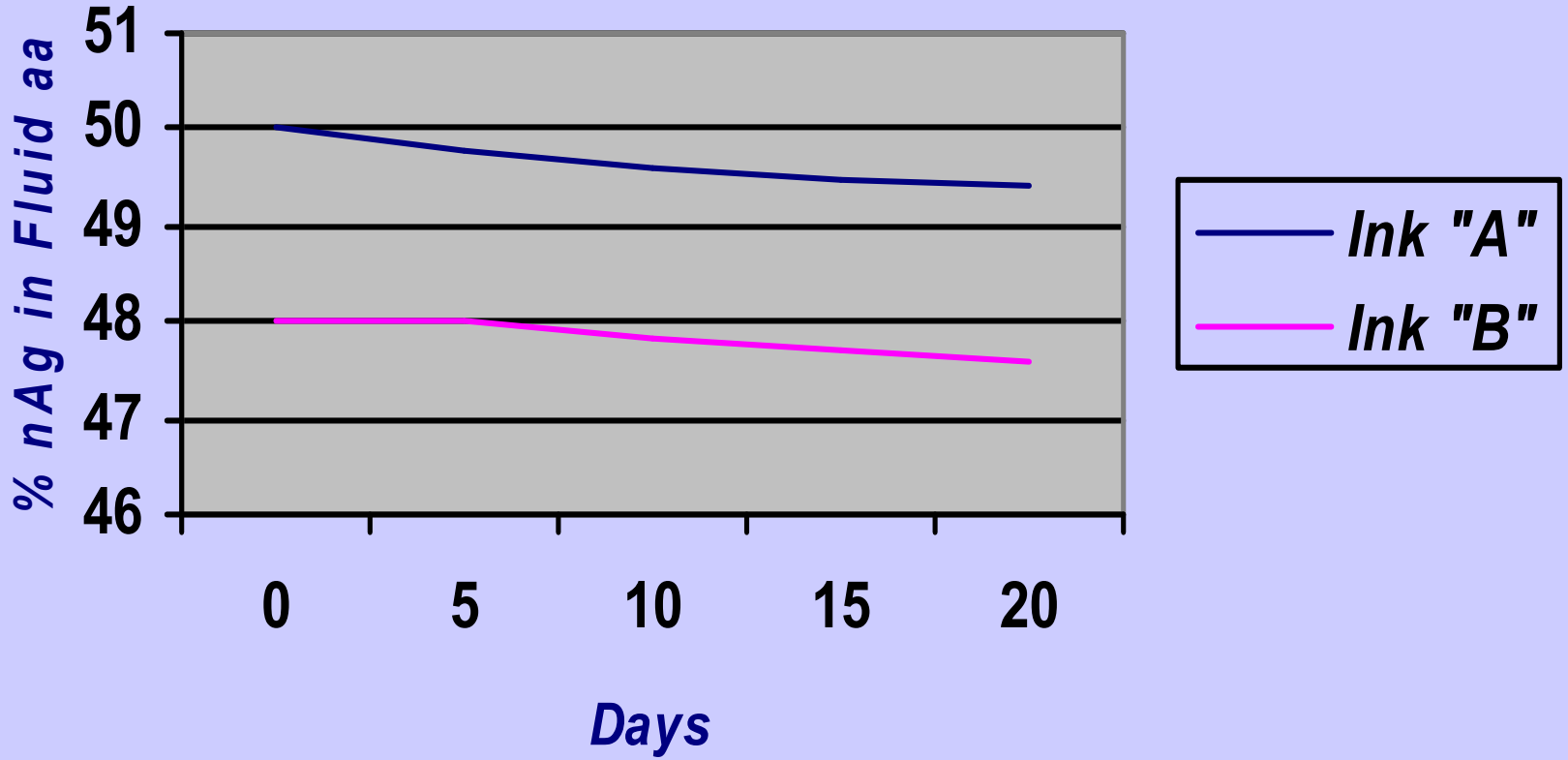
Nano Ink Stability Tests

Ink Viscosity versus Time



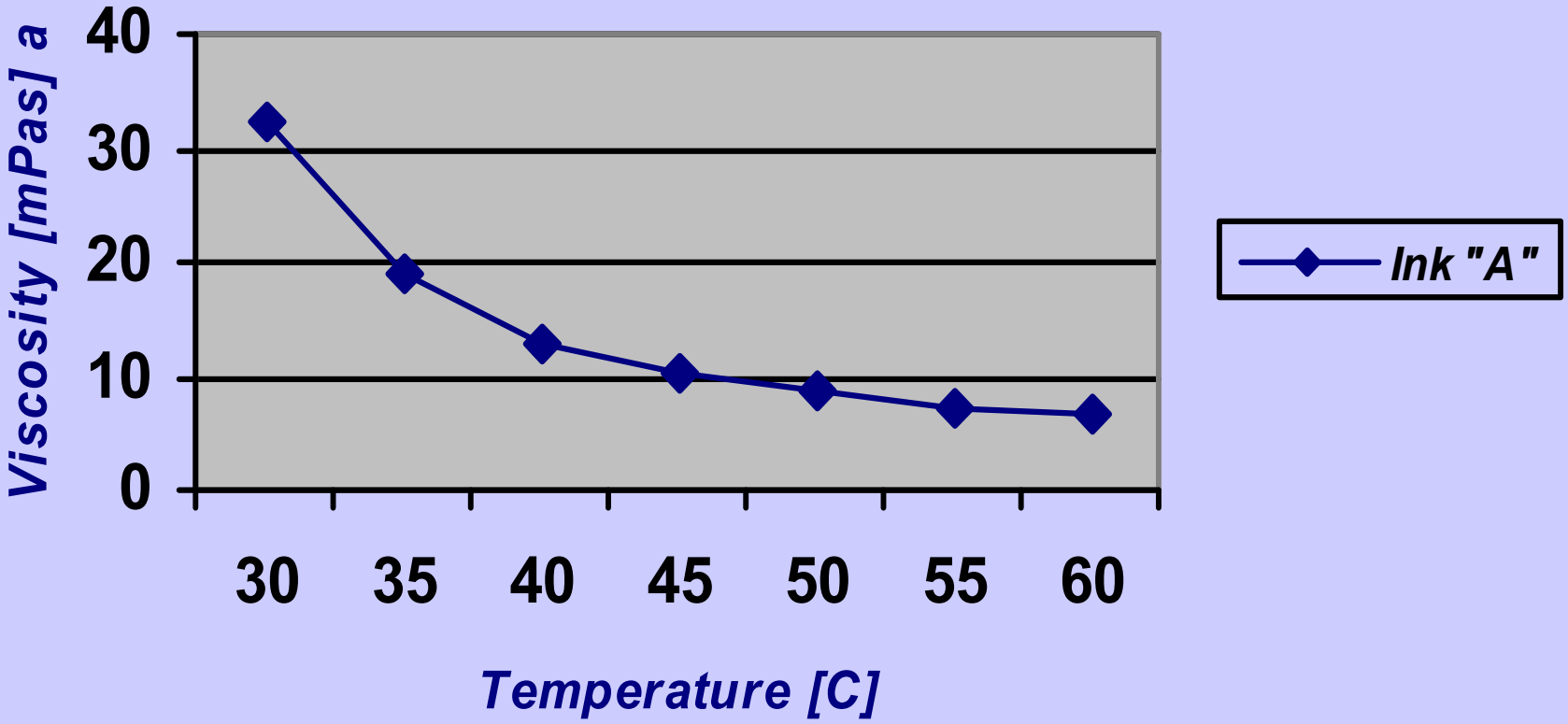
Nano Ink Stability Tests

Silver Sedimentation versus Time

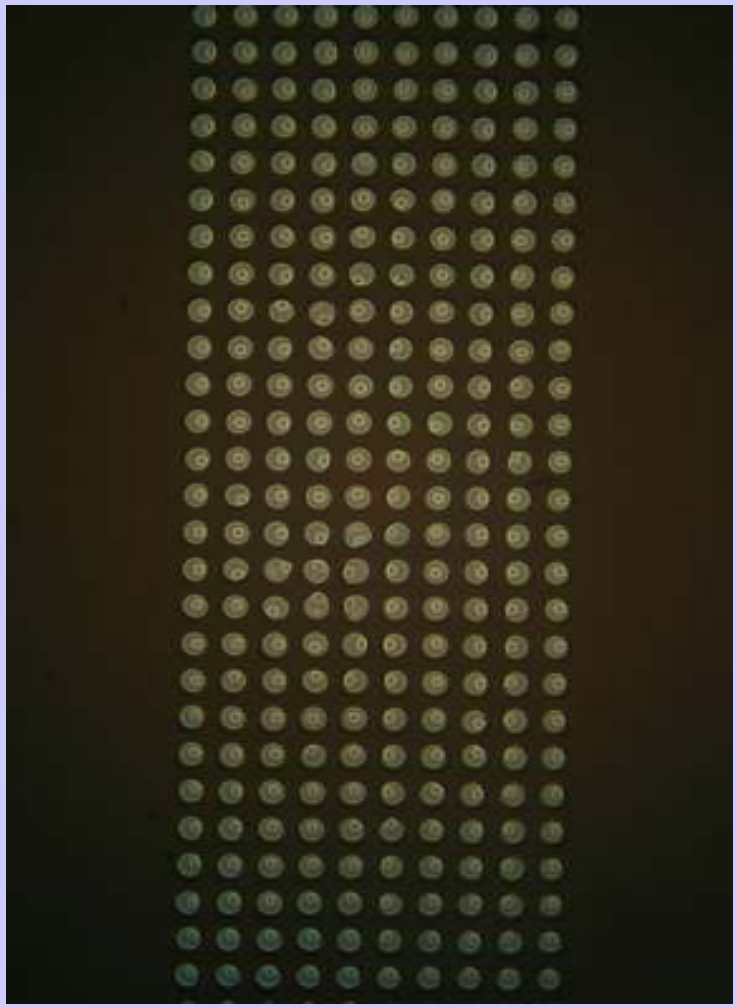


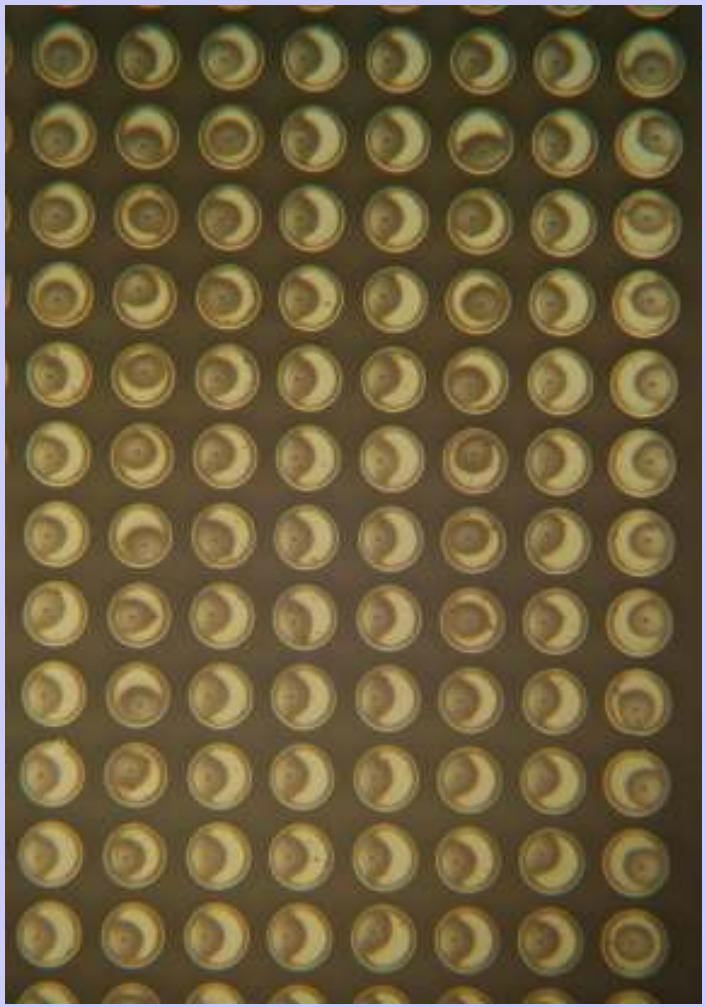
Nano Ink Stability Tests

Ink Viscosity versus Temperature



Samples of Dispensed Ink by Ink-Jet dispenser



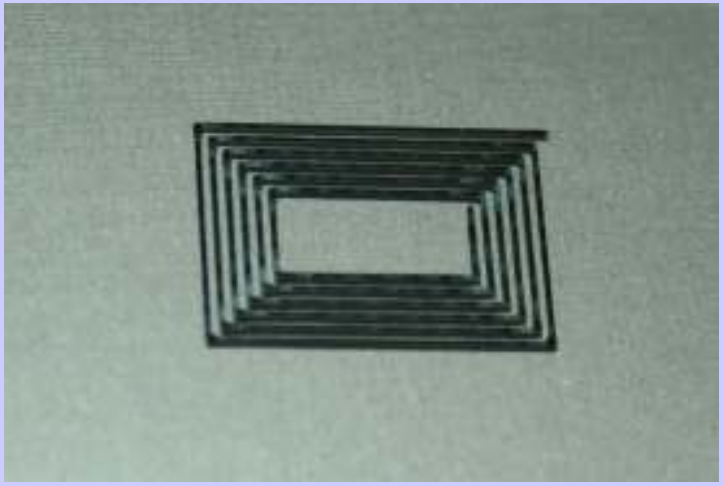


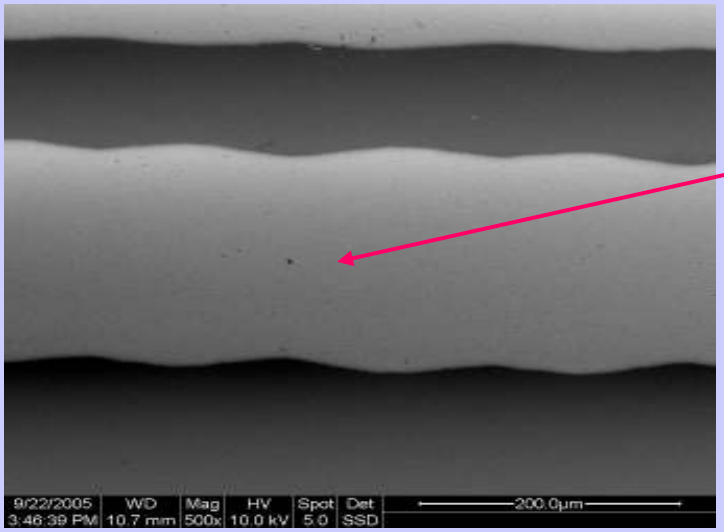
Courtesy of Microdrop Technologies GmbH

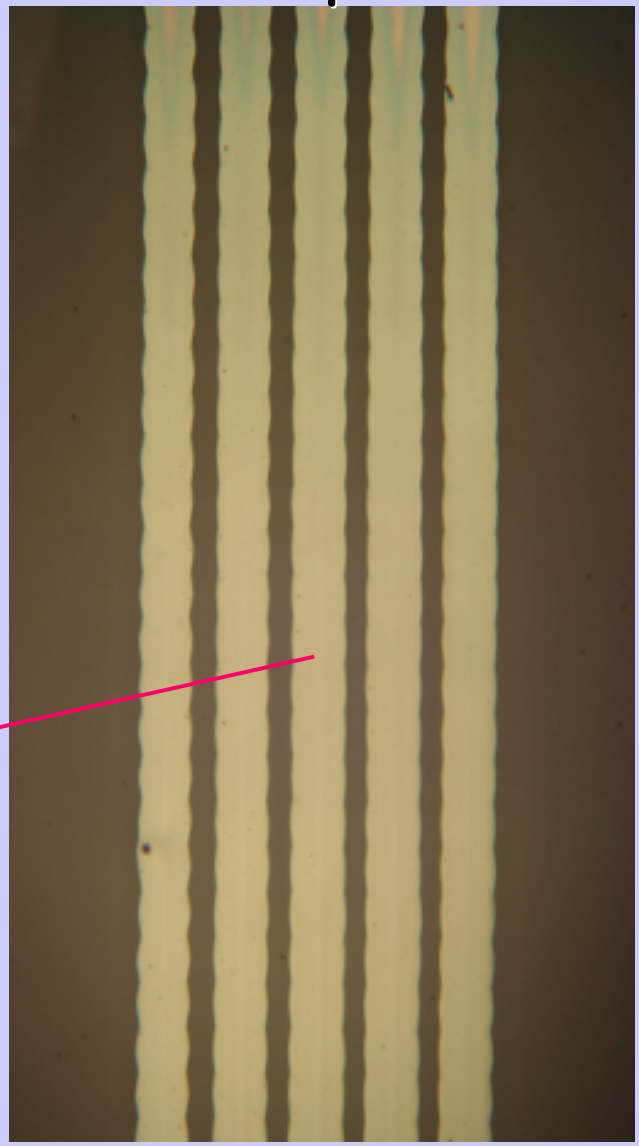
Nozzle Φ = 34 µm

Nozzle Φ = 66 µm

Samples of Dispensed Ink by Ink-Jet dispenser







Courtesy of Microdrop Technologies and TNO Industrial-Eindhoven

Summary:

- The studied inks show properties similar to true fluids
  - Nano silver filler with so small size has the main influence for practically no sedimentation phenomena.
  - Obtainment of the large concentration of nano silver filler without the significant inks viscosity growth is a result of using small silver particles size.
- Stability of ink properties, especially with viscosity point of view is extremely important from print head safe work and repeatability of printed structures.
- Ink with nano size silver filler, after sintering process has highly uniform structure similar like in case of metal wire.