FluidANT Frequently Asked Questions

Version 4.0

FluidANT

What is FluidANT?

FluidANT is print technology which enables you to produce high performance antennas, sensors and electrical circuits on 3D surfaces using conductive ink. Process suits also to printing dielectric materials and to other applications in which the high speed, excellent accuracy and precise deposition rate are important.

FluidANT consists of the FluidWRITER printer and related CAM design software for the print work programming.

What are the biggest benefits of FluidANT?

With FluidANT you can print on 3D part made from commonly available material with good mechanical properties and wide choice of colors. The print system enables significant reduction in prototyping and versioning time. It also opens a new industrial design and integration options and the printing locate next to the device assembly without long process chain or complex logistics.

How does FluidANT compare to other printing technologies?

Other existing printing techniques, like screen and pad printing, are either limited to 2D applications or use, like inkjet or aerosol jet, high cost nanoparticle inks.

Unlike in traditional dispensing systems, in FluidWRITER printers the PrintHEAD operation is synchronized in real time to actual motion which makes it capable to very precise dosing in high speeds. Printed line width and thickness remain stable in all situations. Unique digital 3D offset setting together with advanced control SW enables accurate printing on rotary three dimensional surface.

What substrate materials can be used?

FluidANT can be applied on normal resins with good mechanical properties and wide choice of colors, resins do not need any additional additives. The most common are polycarbonate grades. Polyamide grades are used with care on molding parameters. Also wide range of other resins can be used.

Tested plastic resin grades are listed in design guideline.

What substrate materials can be used?

- Ink adhesion on each substrate material must be tested separately
  -tape test (ASTM 3359-02) before and after environmental tests
  -standard environmental tests: damp heat, change of temperature and salt mist test (IEC 60068)
  -tested and approved substrate materials are listed in FluidANT design quideline
- If customer has substrate material that is confidential information it must be tested carefuly: ink adhesion on substrate material before and after environmental tests, surface roughness and printing quality must be also checked
- Ceramic, metal, glass are the substrate materials to be tested and approved next in FluidANT. Detailed material code/type and environmental requirements for the application is needed to know using those spesific substrate materials and to test the ink adhesion.

What are substrate materials for higher temperature?

High temperature plastic substrate materials

- **LCP** (Liquid Chrystal Polymers) plastics has high temperature resistance and also good chemical resistance (high material price)
- LCP grade Vectra E130i (natural) was tested in FluidANT. Ink adhesion was acceptable, but differences in adhesion in different points/areas appeared in injection molded part
- Injection molding of LCP grades and material flowing into the mold has much effect on molded part and its surface properties and ink adhesion on it
- Raw material price for LCP material is higher than for typical plastic materials used generally and also in FluidANT printing
- Because of good chemical resistance of most high temperature plastics, silver ink adhesion must be tested carefully for molded parts case by case and environmental tests must be carefully done. Typically, the better the chemical resistance of substrate material the more challenging to get good silver ink adhesion on it.

Any substrate pre-treatment requirements before printing?

- Cleaning with alcohol might be needed in case of oil residues from e.g. substrate molding process
- Air plasma treatment for substrate surface prior printing must be done to increase the surface energy and to clean the surface to get good ink adhesion.

What type of silver inks can be used in FluidANT?

A viscosity and a particle size defines capability of FluidWRITER printer to dispense desired ink.

With FluidANT standard setup it is possible to create antenna patterns and conductive traces by using high viscosity micron particle silver inks. Benefits of micron particle inks are low cost and good conductivity. It is always recommended to verify in advance the compatibility of an ink and a substrate securing e.g. good adhesion.

What type of silver ink can be used in FluidANT?

Ink type	Thickness, microns	Line width, mm	Adhesion	Sheet resistance, mOhms/sq/mil
Micron particle ink	Single line, 35+/-10	0,4 +/- 0,1	OK	<15
Nano particle ink	Single line, 4-6	0,2-0,25	NOK	4-5
Hybrid ink	N/A	N/A	N/A	N/A

Pay attention, nano particle and hybrid inks are still under developing process. Challenges in printing process and also in drying process have been appeared in tests and still much development work is needed.

Main characteristics of nano ink are:

- Particle size below 100 nanometers
- High viscosity
- Sheet resistance 4-5 mOhms/sq/mil (25 microns)
- Flat nozzle hole diameter 0,03-0,05 mm

Hybrid inks

- Contains both micron particles (below 10 microns) and nano particles (below 1 micron)

What are the drying temperatures?

- Higher conductor ink drying temperature produces better conductivity, therefore the drying is typically set as high as possible for the used substrate material.
- Maximum drying temperature for micro particle polymer based inks is typically around 200C and minimum drying temperature around 70C.
- Lower conductivity due to low temperature drying can typically be compensated to some extend by longer drying time.
- Typically silver ink drying temperature in FluidANT is optimized so that thermal resistance of plastic substrate is considered.

What are the drying temperatures?

- For decreasing resistance 15 minutes leveling at room temperature is needed for printed ink and standard printed thickness prior drying at oven
- Silver ink drying, 105-115°C, 25 minutes in conventional oven is standard profile for polycarbonate (PC) material
- For other substrate materials t.e.g ceramic, metal, high temperature plastic materials, higher drying temperature can be used, but still not over 200°C (ink resin decomposing over temp. 200°C)

What is the typical hardness of FluidANT printed and dried layer?

- Based on the information from the ink supplier the surface hardness in current micro ink is Pencil Hardness 2H.
- In silver ink approval stage for FluidANT process a kind of abrasion test was done by cycling silver ink printed contact pad by c-clip with spring force 0,5-0,8 N. The ink layer thickness was measured on contact pad. Quantity of cycles was calculated and abrasion of printed pad was verified.
- For standard polycarbonate substrate material and current silver ink after 700 pressing cycles by c-clip and 0,8N spring force the printed pad was abraded. Before that only some depression on silver surface could be seen and silver layer was still unbroken. Thickness of printed layer was ~ 50 microns in the test.
- Abrasion resistance of printed silver depends on the layer thickness and printed ink drying process. After low drying temperatures (<70 C), printed layer is soft and abrasion resistance is bad. Also conductivity is lower.

Is there a typical ink adhesion force for the most common plastic substrates?

- Adhesion forces are not measured.
- Adhesion is depending much on substrate material characteristics; the chemical resistance and surface quality (porosity, roughness)
- Also printed ink drying conditions and chemical composition of the ink itself has much effect on the ink adhesion
- Ink adhesion on substrate surfaces is tested in FluidANT by tape test (ASTM D-3359-02) and the classification is 5B
- For polycarbonate grades tape test is passed, also it is passed for certain polyamide grades and some other materials listed in design guideline.

What is the standard FluidANT setup?

The setup includes:

- Cone-shape nozzle with a hole diameter of 0.1mm
- Micron size particle ink
  - A particle size ~10 microns
  - High viscosity
  - Sheet resistivity <15 mOhms/sq/mil (25 microns)

What are the main tolerances in case of micron particle ink?

Single line width about 0.4 mm

Single line width tolerance ±0.1 mm

Typical single line thickness (printed using 4 drops per mm) 0.03-0.04 mm

Single line thickness tolerance ±0.01 mm

Tolerance from the substrate's edge ±0.15 mm

Minimum gap between the lines 0.4 mm

Minimum gap tolerance ±0.1 mm

Tolerance inside the printed line (line to line distance) ±0.1 mm

Recommended radius on substrate R0.6 mm
(where the printed line continues over the edge)

NOTE: *Substrate material and part surface quality effect on the actual line width and thickness

What are the environmental effects / oxidation of silver printed conductors?

- Silver surfaces are easily oxidized when exposed to the air containing small amounts of impurities
- Oxidation of silver is a natural tarnishing reaction with air impurities, like sulfur and humidity in the air
- Oxidation can be seen as a darkened appearance on the silver conductor surface
- Oxidized silver layers are still conductive and have not recognised to have decreasing effect on the performance of printed pattern.

Is soldering possible on FluidANT pattern?

- Soldering process for Pulse approved polymeric inks is not recommended by the ink suppliers
- Temperature resistance for silver ink, max 200°C (because of polymeric resins in the ink) must be considered
- Because of silver ink temperature resistance (<200°C), low temperature soldering with low temperature solder alloy is the option if the soldering is “must“
- Local heating system should be used in soldering
- Process window in soldering is very narrow: silver dissolving in solder joint and cut in conductivity if the peak time or peak temperature in soldering is too high, or if the printed silver layer is too thin. Thick silver layer is at least required in soldering pads, > 60 microns.
- Soldering process must be well-controlled
- Soldering need to be carefully tested in the cases where it is the only option

What are the other fluids that can be printed in Fluidant?

- Carbon inks
- Gold inks
- Dielectrics, cross overs
- Glop tops
- Glues