Fujifilm Dimatix, Inc.
2250 Martin Avenue
Santa Clara, CA 95050-2704

# Fujifilm Dimatix Jetting and Printing Evaluation

Fluid Utilized: PV Nanocell I50T-1 and I40T-1
Silver Nanoparticle fluid with 50% & 40% Metal Loading

***Summary of Results:***
The PV Nanocell I50T-1 Silver Nanoparticle fluid jets well. The waveform was based from the Dimatix Model Fluid waveform with minor modifications. A single pulse waveform was created for this test. Test patterns were jetted onto standard glass slides. On initial inspection the typical "coffee ring" effect was not noticed. The coffee ring effect is where the fluid has a tendency to pool at the outer edges leaving a lower depression in the center of the pattern. This is the first silver fluid we have seen which does not exhibit this phenomenon. The jetting was consistent and all nozzles jetted even after leaving the print head and cartridge in the printer over night.

**Parameters:**

| Single Pulse | |
|---|---|
| Print Head Type: | DMCLCP-11610 10pl |
| Cartridge Temp: | 35C |
| Platen Temp: | 40C |
| Firing Frequency: | 5 kHz |
| Firing Voltage: | 35 volts |
| Drop Velocity: | 5 m/s |
| Meniscus Pressure: | 160 mmH2O |
| Print Head Height: | 0.50 mm |
| Number of Nozzles: | 16 |
| Filter Used: | none |

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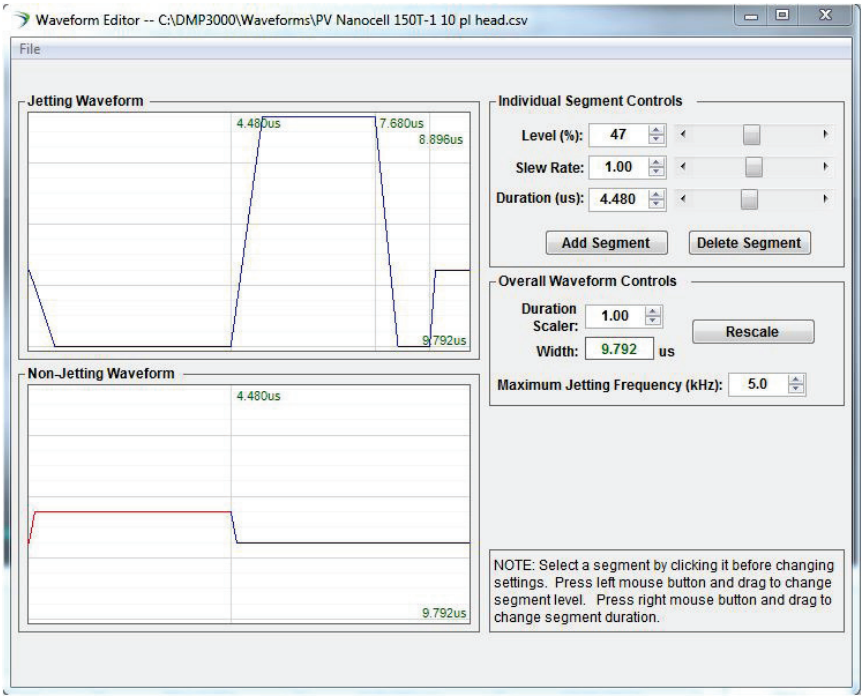
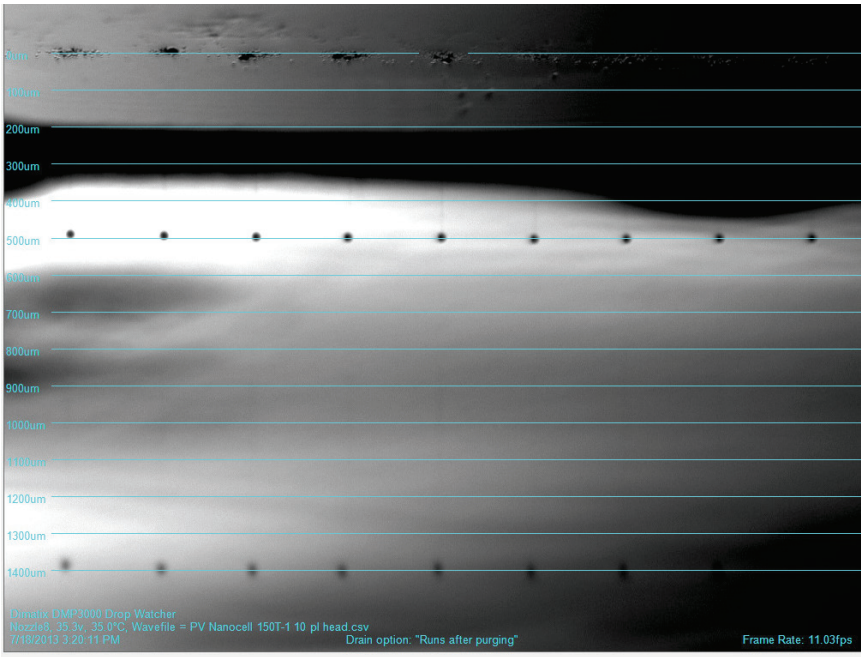
**Jet-ability and Drop Formation tuning:**

The waveform was based on the Dimatix Model Fluid and modified to optimize drop speed and formation. A cancellation pulse was used to keep the ligaments straight while exiting the nozzle. Drop speed was adjusted to 5 meters per second to match the print head to substrate distance. The nozzles jetted the fluid consistently and reliably with a long open time. Leaving the print head in the printer over the weekend was able to jet after a 0.8 second purge and all 16 nozzles fired. This is very good for reliability in a production environment.



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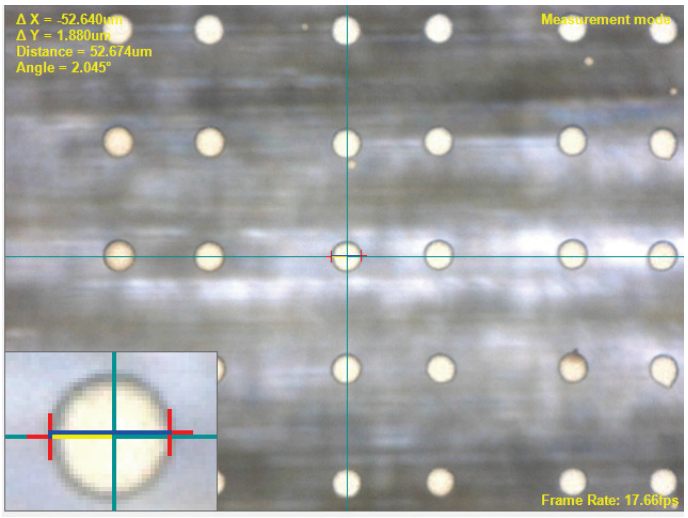
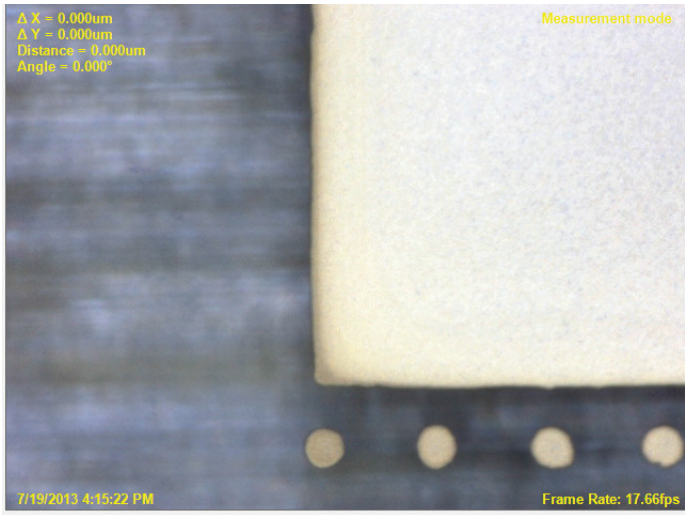
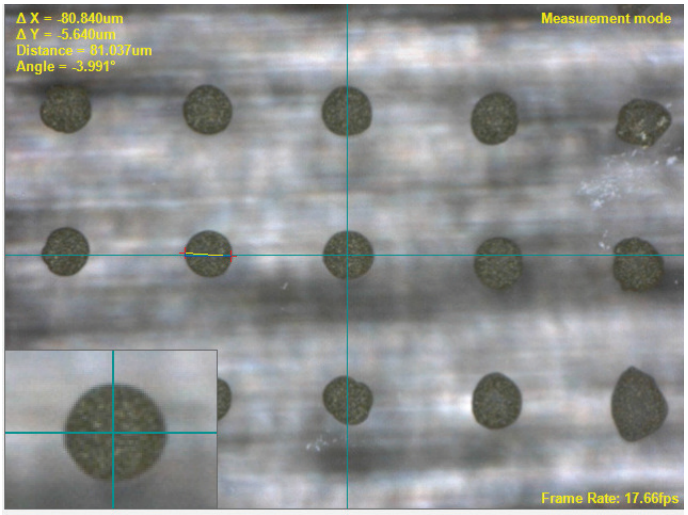
**Print Results:**
Using plain glass slides as a test substrate, the drop diameter was measured at an average of 52 microns. When using UV Ozone to treat the glass slide surface, an average drop diameter was measured at 80 microns. For large fills, the fluid cured flat and did not show typical coffee ring effects. With our standard 25 mm long line with a width of 1mm test print, we measured conductivity on 1.5 Ohms. This is very good and the lowest we have seen with silvers on glass with this image file. Typical measurements fall between 25 to 30 Ohms for other silvers.



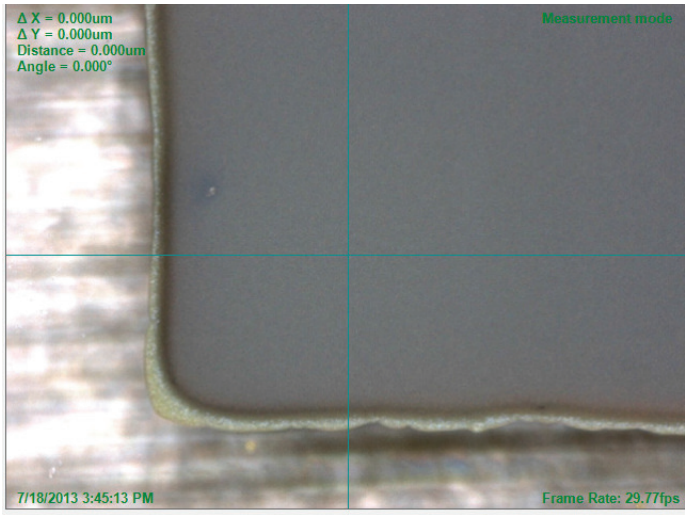

Standard glass slide with no surface treatment provided 52 micron drop diameters.




Solid fills were smooth and consistent as well as the drop and line formations.




Using UV Ozone surface treatment the drops spread to 80 microns in diameter. This allows for drop con-




This is an image capture of uncured fluid showing smooth ink flow and coverage.

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***Summary Results of I40T-1:***

PV Nanocell I40T-1 Silver Nanoparticle fluid jets well. Drop formation and registration results are similar to what found in I50T-1 formulation. It works with both waveforms, standard and modified one as illustrated. Drive voltage is slightly lower, probably because it has 10% less solid content.

**Parameters**

| Single Pulse | |
|---|---|
| Print Head Type: | DMCLCP-11610 10pl |
| Cartridge Temp: | 35C |
| Platen Temp: | 35C |
| Firing Frequency: | 5kHz |
| Firing Voltage: | ~30 volts |
| Drop Velocity: | 5 m/s |
| Meniscus Pressure: | 150 mmH2O |
| Print Head Height: | 0.5 mm |
| Number of Nozzles: | 16 |
| Filter Used: | none |

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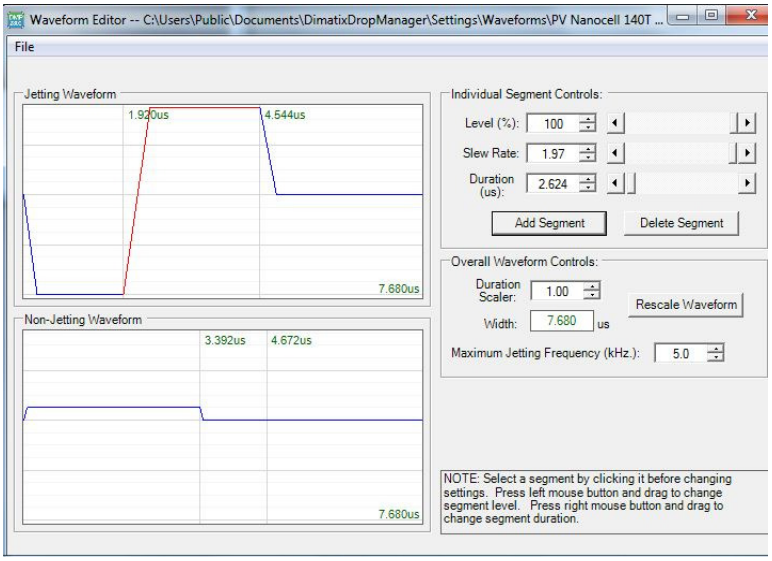
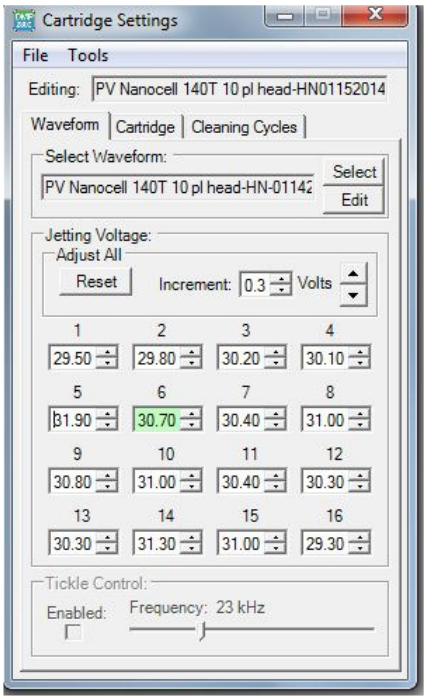
## Drop Formation Tuning and Printing Result:

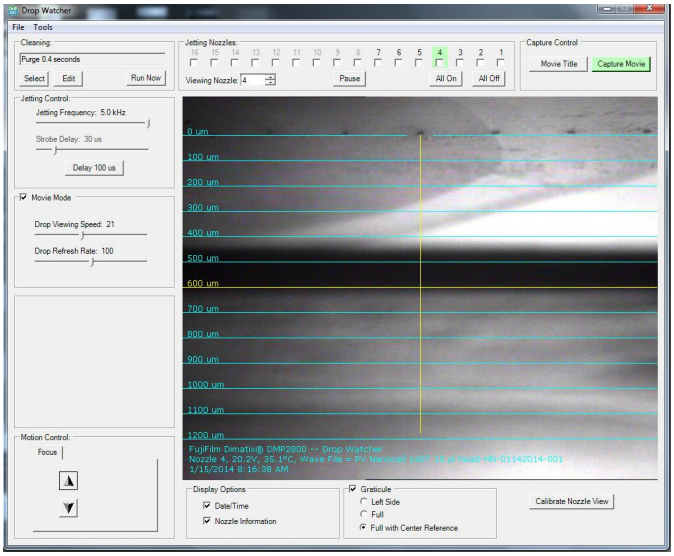
This illustrates that I40T-1 formulation is jettable using standard waveform to produce similar result as shown with I50T-1.



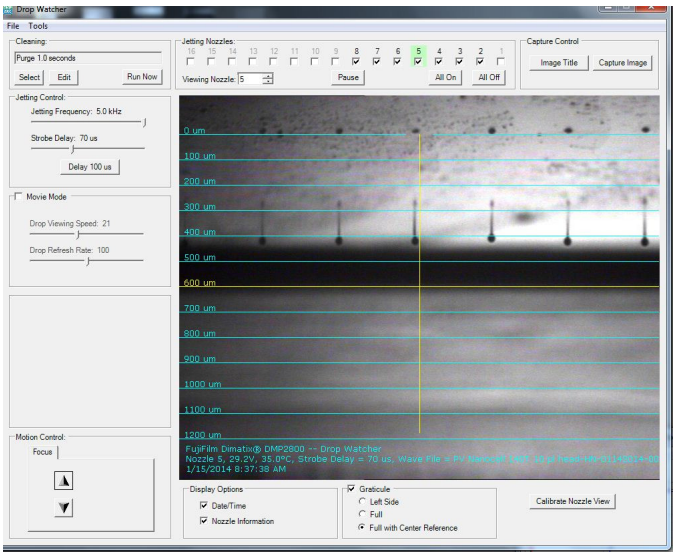

Drive Waveform, std.




Drive Voltage, ~ 30V, slightly less than I50T-1




Meniscus Pressure = 150 $mmH_2O$




Jetting appears to be good as shown here with longer ligament for straightness illustration purpose.

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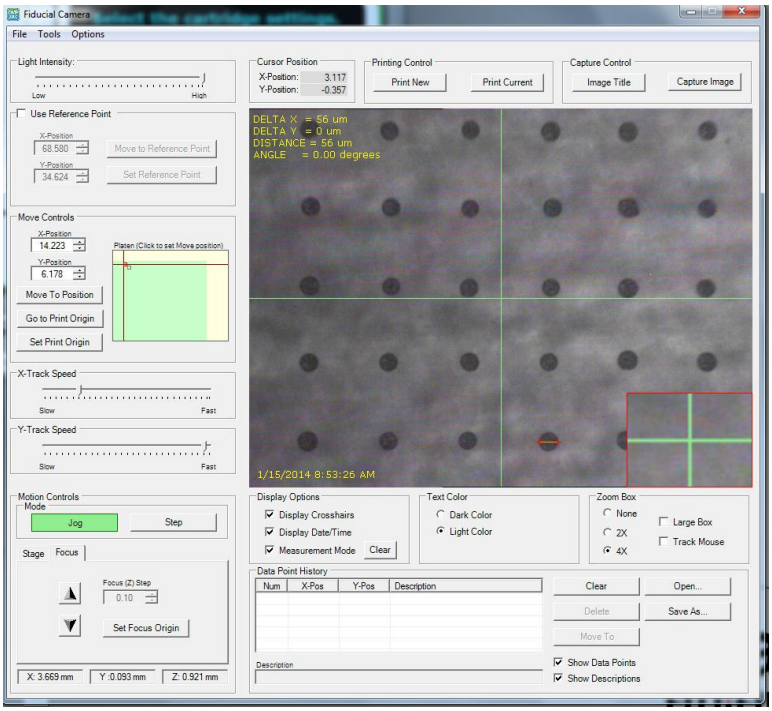
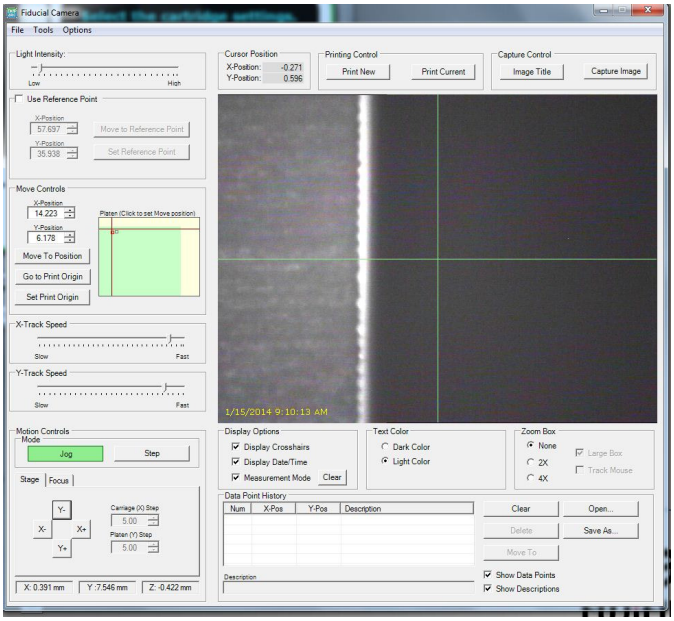
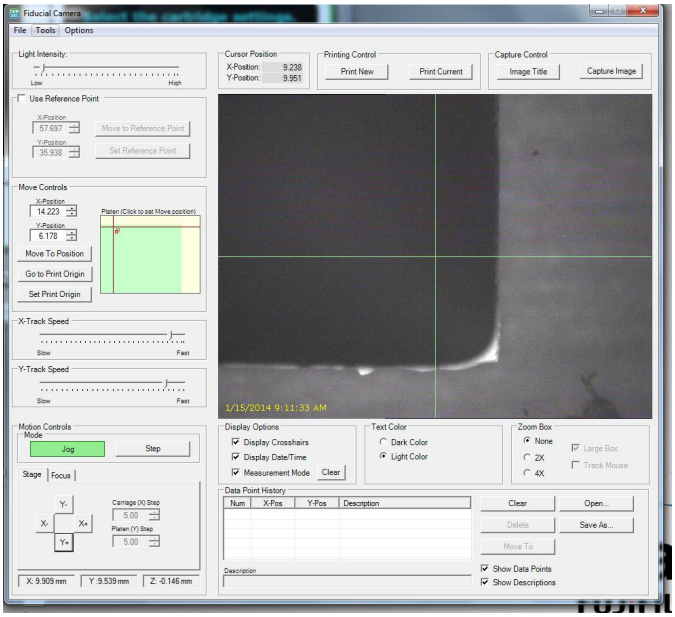



Drop size on untreated glass slide ~56 µm




Drop registration looks good on untreated glass slide as shown here post printing, uncured.

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