

ODT Patterning with 1D Arrays

Dip Pen Nanolithography[®] (DPN[®]) is an established method of nanofabrication in which materials are deposited onto a surface using a sharp tip. The technique has been used to successfully pattern a variety of materials. By using a parallel array of “multi-pen” tips, DPN can reduce patterning time and increase throughput.

A 1D array of 26 “pen” tips was used to investigate the uniformity of a pattern printed with 1-octadecanethiol (ODT) onto a fresh gold surface. Several different factors play a crucial role in ensuring uniformity and homogeneity over the patterned area, including:

1. “Pen” tip geometry
2. Loading of print materials onto writing “pen” tips
3. Surface features and contaminants
4. Leveling of “pen” tips

Silicon surfaces coated with a 10 nm thick layer of Au film and a 3 nm of Ti adhesion layer were used as substrates. Dot arrays of ODT were then printed on these fresh gold-coated silicon substrates.

The standard protocol to ODT by DPN was used. Briefly, ODT was coated onto a NanoInk 1D 26-“pen” array (DPN[®] Pen Array: Type F) by thermal evaporation technique. ODT coating was accomplished by running three cycles of 1 hour heating (70 °C) followed by slow cooling (~ 5 °C/hr) to room temperature. All deposition of ODT was carried out under identical environmental conditions of 25 °C and 35% humidity, with a constant dwell time of 4 seconds. Under these parameters, each deposited spot was ~ 700 nm in diameter.

In an effort to obtain data for statistical analysis, three different Type F DPN[®] Pen Arrays were used to construct the patterns. Each “pen” tip in the 1D “pen” arrays was used to construct a rectilinear pattern of 100 spots. Lateral force microscopy images of three to four patterns deposited by different “pen” tips in the 1D “pen”

array were obtained, as shown in Figure 1. ODT dot diameter was measured using the SPIP software “Measure Line” tool.

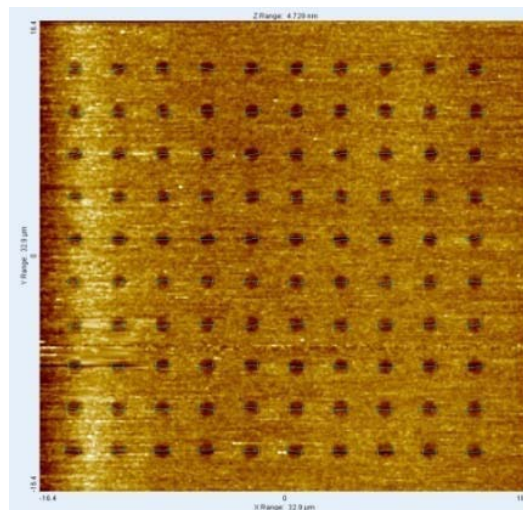


Figure 1. LFM image of a typical ODT dot array generated with a DPN[®] Pen Array: Type F

Coefficient of variation values were calculated to determine the uniformity of ODT patterns printed using the 1D “pen” array. The coefficient of variation for the diameters of ODT spots created using each “pen” tip in the array was 13 - 18% (100 spots per pen). The coefficient of variation of ODT spot diameters across all “pen” tips in one 1D “pen” array was 16 - 17% (300 – 400 spots per pen array). The coefficient of variation of ODT spot diameters across all “pen” tips in three different 1D “pen” arrays was 17% (1100 spots total). A summary of this data is displayed in Figure 2. The gray colored bars in the histograms represent normalized average dot diameter and standard deviation of all spots printed with an array. One interesting point to note is that features written by the feedback pen (lever with laser focused) exhibit ~ 10 % larger spot diameters than features printed by other pens; this is likely due to the heating of the cantilever by the laser.

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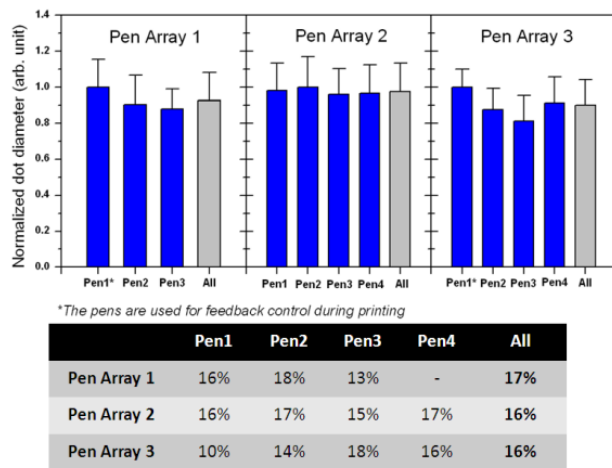


Figure 2. Histograms of normalized dot diameters generated using three independent DPN[®] Pen Arrays: Type F. Three to four “pen” tips from every “pen” array were randomly chosen for analysis. Dot sizes are normalized by the maximum dot diameter in every “pen” array printing. Table shows ODT dot diameter coefficient of variation values.

To summarize, the coefficient of variation for the diameter of ODT spots printed on gold surfaces using a 1D “pen” array is ~17%. This level of variation seems to be consistent when using single and multiple “pen” tips in a 1D “pen” array or when using multiple 1D arrays of “pens.”

NanoInk Products Used

DPN 5000 System
 DPN[®] Pen Arrays: Type F
 DPN[®] Substrates: Gold

Learn more about NanoInk products and services at www.nanoink.net. Or call us at 847-679-NANO (6266).

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