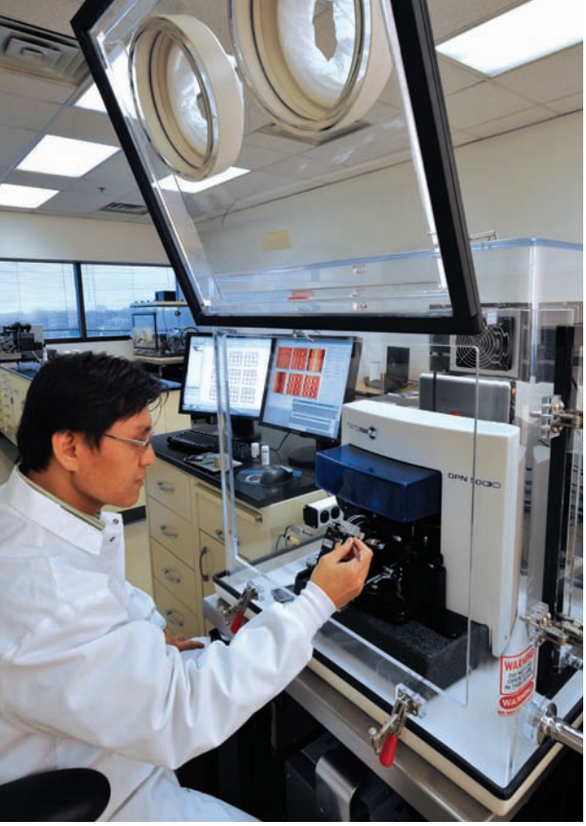
NANOINK INC®

NanoFabrication Systems

DPN® Nanofabrication Systems

A complete line of instruments and tools for micro and nanopatterning applications



DPN® Nanofabrication Systems

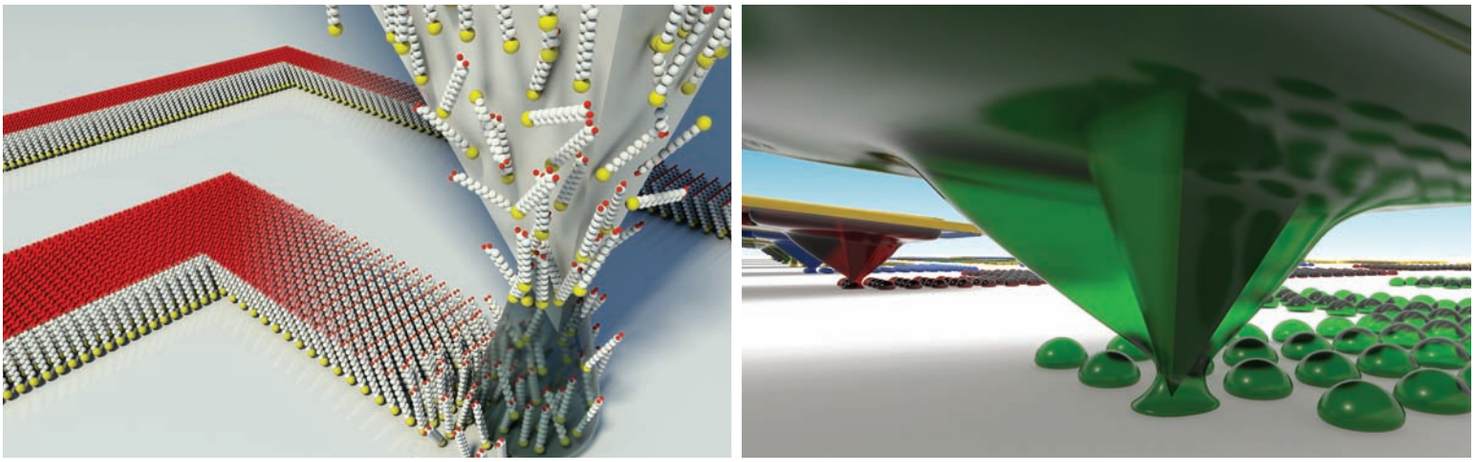
A complete line of instruments and tools for micro and nanopatterning applications

Benefits

- Feature sizes 50 nm to 10 µm
- Flexible, rapid fabrication with single or multiple materials
- Bio-compatible deposition process
- Scalable patterning using arrays of “pen” tips
- Materials deposition at addressable locations

DPN Technology: Powerful and User Friendly

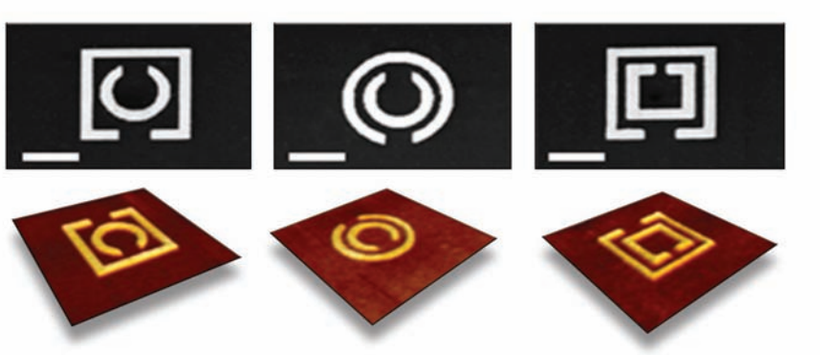
Dip Pen Nanolithography® (DPN) is a direct write, tip-based lithography technique capable of multi-component deposition of a wide range of materials with nanoscale registry. DPN makes it fast and easy to create user-defined patterns with feature sizes as small as 50 nm or as large as 10 μm on substrates such as glass, plastic, gold and silicon. Using NanoInk's benchtop DPN systems, software and proprietary MEMs tools, researchers can directly print biomolecules, hydrogels, alkanethiols, silanes, polymers, and nanoparticles over large pattern areas with incredible speed. The DPN family of systems has the ability to design, deposit, and characterize a wide range of feature sizes on the benchtop without the need for a cleanroom, master stamp or photomask. Pattern design and product production are highly scalable and can be completed in less than an hour.



DPN systems have the flexibility to print a) molecular or b) liquid materials.

Top-Down Lithography

The top-down DPN technique is ideal for rapidly prototyping structures such as diffraction gratings, plasmonic features, and arbitrary solid-state patterns (including photomasks). DPN is used to deliver etch resist material to an existing surface in pattern features ranging from 50 nm to 2 μm. The substrate is then immersed in an etch solution to remove material from all areas except those where etch resist was patterned.



AFM topographic images of split-ring resonator structures fabricated using top-down DPN.

Bottom-Up Lithography

With the ability to pattern materials to a planar surface or to an existing micro or nanostructure, DPN techniques are broadly applicable in bottom-up fabrication processes and can be used to functionalize biosensors, PDMS stamps, microfluidic channels, membranes and nanowires. DPN is a fast and affordable lithography solution.

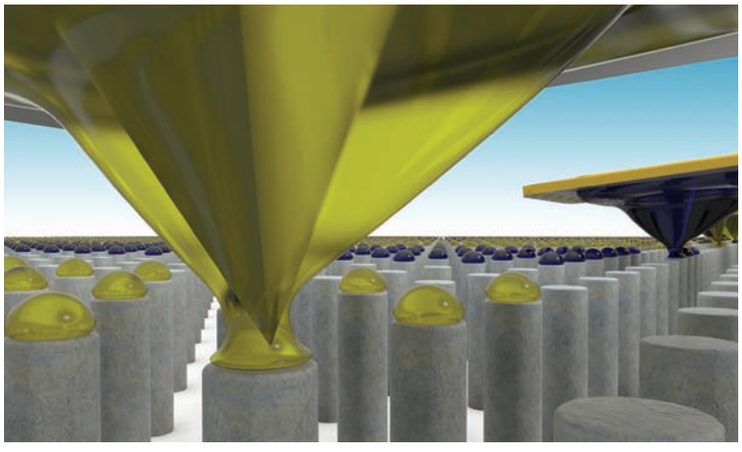


Illustration of bottom-up DPN microstructure functionalization.

Unrivaled DPN Technology Capabilities

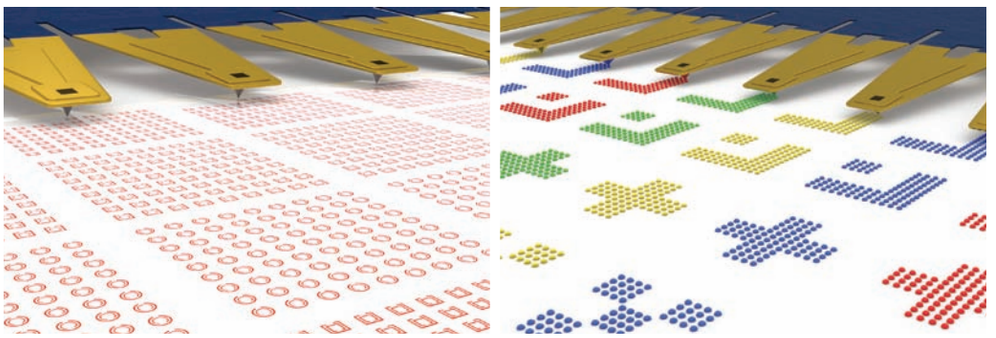
DPN is the *only* commercially available technology platform capable of depositing multiple materials in nanometer to micrometer sized features with nanoscale registry. This unparalleled technology forms the core of NanoInk's family of instruments, from powerful and precise AFM-based systems to benchtop systems capable of patterning large areas. All DPN systems are highly flexible, simple to learn and user-friendly and they do not require a cleanroom or dedicated infrastructure. *DPN technology can achieve the following:*

Feature Sizes 50 nm to 10 µm

NanoInk's MEMS-fabricated "pen" tips, optimized for DPN deposition of molecular or liquid materials, enable control of feature size. By controlling "pen" tip dwell time and the deposition environment, users of the DPN family of systems can quickly and easily create features ranging from nano to microscale in size. Powerful, user-friendly system software drives high resolution stages to ensure nanoscale accuracy and repeatable patterning in x, y, and z.

Flexible, Rapid Fabrication with Single or Multiple Materials

Using the DPN family of instruments, researchers can rapidly create unique patterns, going from pattern design to printed substrate in less than an hour. Molecular or liquid printing materials are loaded onto "pen" tip arrays using reservoirs that feed liquids through microfluidic channels. Each "pen" tip in a tip array can be loaded with a unique printing material. Once the "pen" tips are loaded, the DPN system simultaneously deposits multiple materials and multiple features onto the chosen substrate, creating a fully user-defined printed pattern.



DPN "pen" tip array printing multiple patterns using: a) one molecular printing material and b) many different liquid printing materials.

Biocompatible Deposition Process

DPN does not subject biological materials such as proteins, peptides, and nucleic acids to compression forces, shear forces, harsh vacuum, or UV light conditions that can damage structure and function. As a result, features generated using the DPN family of systems contain higher percentages of bioactive materials. NanoInk's "pen" tips can successfully print liquid materials with viscosities ranging from 1 to 20,000 cP. Printed features are uniform in size and shape and exhibit no trace of the "coffee stain" effect often seen with other printing platforms.

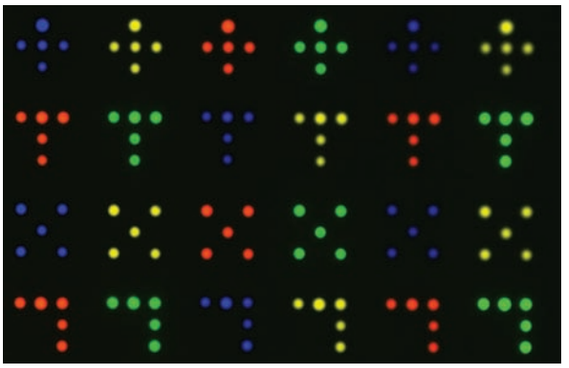
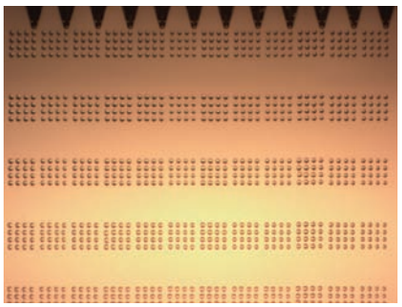


Image of DPN antibody nanoarray with features 4 µm in diameter and 16 µm in pitch.

Scalable Patterning Using Arrays of "Pen" Tips



When printing materials with "pen" tip arrays, a single array-sample contact event can simultaneously deposit tens to thousands of features. Sophisticated DPN system leveling capabilities ensure uniform contact of all "pen" tips across the substrate, resulting in highly consistent spot morphology.

Screen shot of multiple DPN "pen" tips depositing uniform 6 µm features.

Materials Deposition at Addressable Locations

High resolution x, y stages coupled with the latest imaging systems and leading-edge software allow the DPN platform to deposit materials at desired locations with nano to microscale accuracy. This accuracy makes the DPN family of systems ideal for the functionalization of pre-fabricated microstructures for sensing, microfluidic, and cell culture applications. DPN fabrication processes are also especially valuable for the construction of electrodes on nanostructures such as nanowires or graphene sheets.

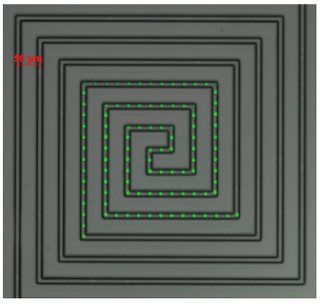


Image of DPN-deposited protein features on the ridges of a PDMS stamp.

Empowering Unique Applications

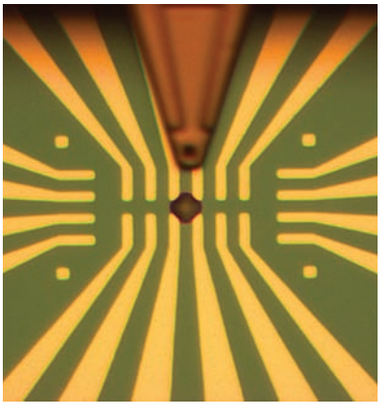
The ability of the DPN family of systems to directly deposit multiple materials in multiple patterns at addressable locations while under ambient conditions enables cutting edge nanofabrication, nanoengineering and nanobiological applications.

Nanoengineering

DPN processes are unmatched in their ability to rapidly prototype and fabricate the following nanostructures:

- **Metamaterials:** Split ring resonator structure fabrication
- **Gratings:** Large scale diffraction grating creation
- **Carbon Nanotube Seeding:** Metal nanoparticle (singular or array) deposition to catalyze carbon nanotube initiation and growth
- **Graphene:** Electrode fabrication on graphene sheets

Microstructure Functionalization

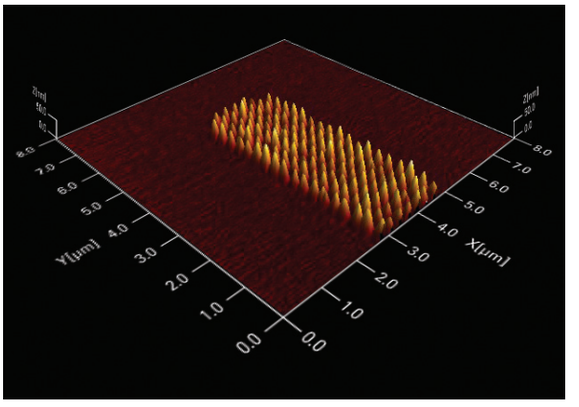


Because the DPN family of systems can deposit sub-10 µm features of multiple materials with nanoscale precision at addressable locations, the platform is ideal for functionalizing prefabricated microstructures. Examples include sensing elements in biosensor or chemical sensor arrays, micropillars, microelectrodes and defined locations inside microfluidic channels.

Image of DPN tip functionalizing electrode arrays with a protein solution.

Biomaterials

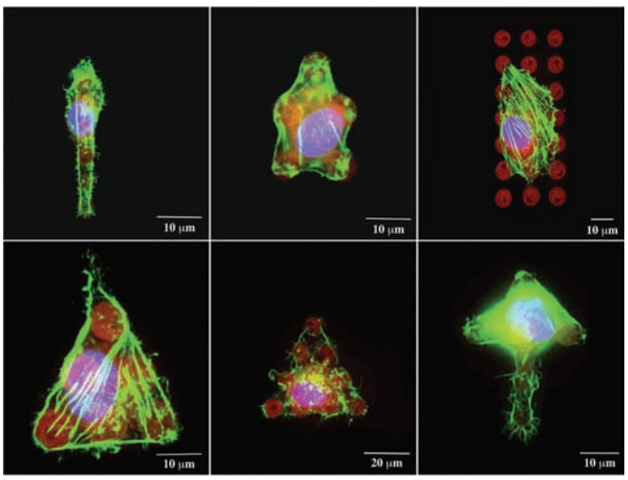
Hydrogels patterned at sub-cellular resolution facilitate cell micropatterning, tissue engineering, and *in vitro* cell culture studies. Researchers value DPN for its ability to deposit hydrogel precursors at defined locations in a controlled, consistent manner and to subsequently polymerize these precursors to form hydrogels. The DPN family of systems is also adept at patterning DNA, proteins, lipids, and other biocompatible materials.



3D topographic AFM image of DPN-deposited PEG hydrogel precursors with feature size of 150 nm and feature height of 37 nm.

Cell Biology

The DPN platform's biocompatible deposition process and rapid prototyping capabilities make possible the manipulation and study of live cells. The ease with which DPN systems can construct complex patterns of biological materials at sub-cellular scales and then attach single cells to these patterned features makes DPN the perfect solution for probing underlying mechanisms of cell behavior like cell polarization, morphology, migration, adhesion, differentiation, and stem cell lineage. Using DPN-deposited hydrogels, researchers can also expose individual captured cells to unique materials and then study the biological effect of compounds of interest at the single cell level.



DPN-generated fibronectin (red dots below cells) patterns on glass with bound 3T3 fibroblasts stained for actin (green) and nuclear contents (blue).

Multiplexed Protein Analysis

The DPN family of systems can simultaneously deposit multiple proteins, including antibodies, under biocompatible conditions. Since DPN features exhibit highly uniform spot morphology, nanoarray-based protein assays are sensitive enough to detect even low abundance protein biomarkers. With an analyte sample requirement of only 1 µl, DPN is the ideal platform for multiplexed protein expression and protein function studies.

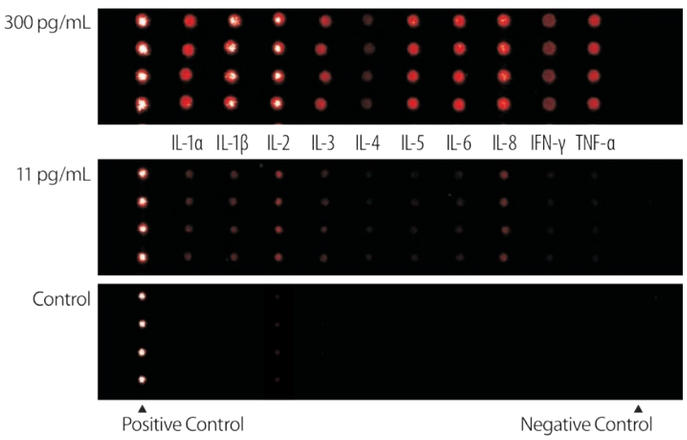


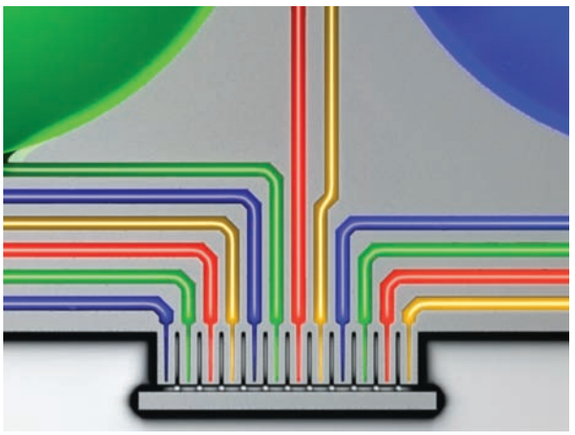
Image of highly sensitive detection of various concentrations of human cytokine antigens using DPN antibody arrays.

Your *Total* Nanofabrication Solution

NanoInk partners with customers to provide fully integrated solution sets of instrumentation, accessories, consumables, software and protocols for many applications. Standing behind every NanoInk system is our unrivalled expertise in nanoscale fabrication and a commitment to application support, service and collaborative development.

MEMS Expertise

With a state-of-the-art MEMS manufacturing facility and an experienced MEMS engineering team, NanoInk consistently delivers the highest quality components for nanofabrication applications. MEMs-fabricated consumables specially engineered for the DPN family of systems include single "pen" tips and multiple "pen" tip arrays optimized for specific types of DPN deposition work, DPN substrates marked with addressable location labels, and InkWell Arrays designed to deliver print materials to one or several DPN "pen" tips. Our dedicated MEMS team can also conduct custom MEMS project work.



MEMS-fabricated DPN InkWell Array filled with and ready to deliver 4 different protein materials to a DPN 12-"pen" tip array.

Contact us to learn more about NanoInk's family of DPN systems and to determine which instrument best matches your application needs:

www.nanoink.net or **847-679-NANO (6266)**.

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