Nanometrix

The Linear Coating Company

Nanometrix Technology Overview

By

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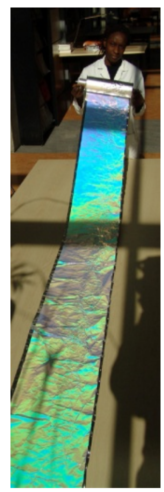
1 Introduction

Nanometrix technical focus is the elaboration of new processes and design of Tools and Formulas for assembling molecular and nanoscale material for the industry. Our fields of interests are the semiconductor, MEMS, photo voltaic, optoelectronic, flexible electronic and flat panel display products among others. The company's IP portfolio is based on three pillars: the Driven Monolayer Assembly Process (DMA) for Monolayer and ultra thin film deposition, the Dynamic Surface Tension (DST) technology for thin film fabrication and the Capillary Bridge modular transfer apparatus and method. These technologies were created for making high quality monolayers, of particles and molecules, polymer and slurries to be coated continuously onto rigid and flexible surfaces.

2 DMA Process

The industrial fabrication of monolayers by the DMA Process was the first Nanometrix technological breakthrough. Monolayers are built by sliding elements on the surface of a liquid until they meet the monolayer formation line. In this process, the natural flatness of liquid surface is used to obtain ultra smooth coatings. Elements are packed one against the other in an orderly and continuous manner. At the same rate that the elements are deposited onto the gas-liquid interface and packed at the formation line, the monolayer is transferred from the interface onto a solid substrate. The whole process works in a dynamic and continuous equilibrium.



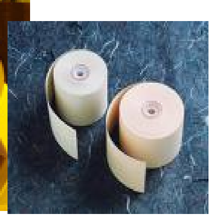
Monolayer of 1 micron SiO_2 beads for pearlescent effects

Ultra Thin Films are obtained in a similar way. A monolayer and Ultra Thin Film generator was created for this purpose and works in automatic mode. The rate of production exceeds one square meter per minute, which means typically, for a molecular scale element that several billion elements per second are integrated in the monolayer matrix. So far, monolayers of many kinds and types of materials have been produced and displayed.

Ultra Thin polymer films are made at the same production rate.
Polymer film thickness can be tailored to have different values starting at 1 nm thick with a mean roughness at the atomic scale (0.1 nm). Thicker polymer films can be engineered with typically a surface roughness under 1 nm. Multilayers made from the superposition of several Ultra Thin Films are also produced.

3 The DST Process

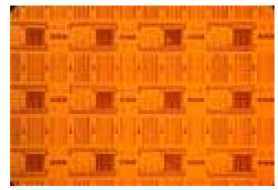
The Dynamic Surface Tension Process (DST), for sub-micrometer and micrometer thick films is also part of Nanometrix technology advancement for our on going application development. The goal: thicker colloidal packing and thin polymeric films with outstanding surface quality control where more material is needed per layer while the coating is performed on a single pass.



Heterogeneous mixtures for multilayer and multifunctional assemblies are layered with the DST Process for resist coats for MEMS, protective coats for masks, optical filters, fuel cells and energy conversion, to name some of the applications where the DST is showing outstanding results.

Nanometrix is providing better ability to control various film characteristics such as thinness, uniformity, molecular orientation, and organization of matter which are providing improved performance, reliability and lower costs. All these improvements respond to an increasing demand for leading edge devices and products that take advantage of recent discoveries in the field of nanotechnology and material science such as optical devices and photonics, flat panel displays, flexible electronics, micro- and nano-electronics, MEMS and nanolithography and eventually for applications such as fuel cell and catalytic devices.

Wafers of all sizes and flexible films can be handled by our coating processes



Optical image of 30 nm
DUV processed resist

4 Features & Benefits

Environmental Advantage

The DMA and DST Processes are environmentally-friendly because the material is layered at the molecular level on the surface of liquid when a coating is applied to the rigid or flexible substrate. Less resist or material is required to coat substrates and less waste is generated than most current coating methods.

Feature	Benefit
Wafer Size	No limits on wafer size and one coater used for all wafer sizes.
Compression Instead of Tension	The resist is assembled by compressing molecules for a coating with few nanometers thickness. No pulling apart of the resist surface in the process.
Minimal Surface Roughness	More consistent exposures, fewer defects.
Resist Thickness	Can be selected to values starting from 1 nm.
Industrial Production	Production rate is in the order of m^2 per minute. Production of three 300 mm wafers per minute.
Materials and Process	Continuous and gentle. Thus far, no limits on material handling have been found with the DMA or DST Processes.
Clean & "Green"	Over 80% of the resist solution stays on the wafer surface. Increases yield per liter of resist and lowers disposal costs.

5 List of monolayer materials coated so far

Particle	Shape	Size
SiO2	Spheres	20 nm - 1.5 µm
PMMA	"	250 nm - 950 nm
Wax	"	100-300 µm
Reflectospheres	"	1- 100 µm
Quantum Dots	"	2 -10 nm
Fluorescent	Spheroids	Blue 1.5 µm
"	"	Green 1.5 µm
Thermo-chromic	"	Blue - white 2 µm
"	"	Pink - white 2 µm
Platinum	"	2 - 5 nm
BSA Protein	"	20 nm
TiO2	Irregular	100 nm
Diamonds	"	250 nm
Graphite	Discoids	100 nm
Graphite-Platinum	"	30 - 100 nm
CNT-Platinum	Bundles	≈ 1 µm
Silicon, Nickel	Powder	≈ 25 nm – 5 µm
Carbon	Chunks	> 1 µm
Carbon-Platinum	"	> 1 µm

6 Thin Films and Ultra Thin Films with DAM and DST Processes

Common resists and polymers for I-line, DUV and E-beam lithography such as; SP1813, UV1400, AZ9260, NED, ZEP and PMMA have been successfully deposited. PVDF, PVPH at different molecular weight and Polyimide are also used for various applications. Our test results indicate surface roughness is commonly <1nm. Thickness variation is in the range of the nanometer.

300 mm Si wafer coated with 3.5 nm resist

7 From Design to Reality

Nanometrix current technology development includes the design and construction of a first Industrial Linear Coating Tool (LCT 1000) for Flexible substrates. First tool construction completion was achieved in December 2007.

The LCT1000 is provided with fully automated monolayer production system, with room for 100 recipes, and CE marking.

LCT 1000 Design

LCT 1000 for web coating

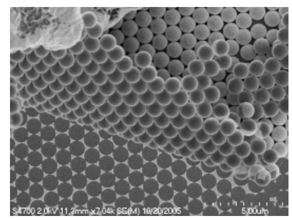
8 Looking Into the Future

Our facilities at the J.-A.-Bombardier Pavillion

Substrates are of many different natures, depending on the application. There are no substrate limitations in using Nanometrix' Linear Coating Process. Nanometrix has successfully deposited coatings on silicon wafers, photomasks, metal foil, plastic rolls, glass slides, fabrics, paper and even Teflon^{tm}.

Our Present tool has shown films with:

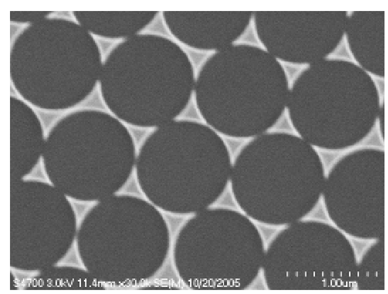
- High degree of uniformity
- Nanometer surface roughness
- Unlimited width, length and shape
- Works with rigid or flexible substrates
- Gentle process



Gold patterning on wafer. The monolayer is used as a mask

Future Application Examples:

- Biosensors
- Medical Diagnostics
- MEMS
- Monolayers and Ultra Thin Films
- Photonic Crystal Devices
- Flat Panel Displays
- Photovoltaic (PV) Solar Technologies
- Fuel Cells
- Organic-Based Solar Cells
- Molecular Electronics (ME)
- Infrared and UV Window Protection
- X-ray Optics / Masks
- 3D Devices Nano-colloidal Gold Films
- Optical Filters
- Fluid (gas, liquid) Filters



50 nm gold patterning on wafer after removal of the monolayer

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