Micro Nano Patterning

PECVD process and polymer films for surface nano texturation

CEA-LITEN, France

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Material class:

Silicon	Polymer	Metal	Ceramic	Glass	Organic	Other
X		X	X			

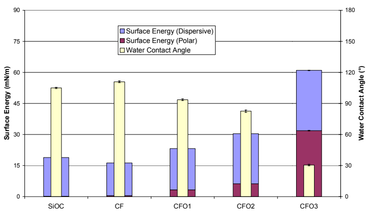
Short technology description:

Both fluorocarbon (e.g. Teflon) and organosilicon (e.g. PDMS) films find extremely diverse applications because of their unique electrical, chemical and surface properties. For instance, potential applications of organosilicon CVD thin films include semi permeable membranes. Polydimethylsiloxane (PDMS) layers are well known to be good polymer membranes for gas separation processes. Plasma enhanced chemical vapour deposition (PECVD) technique has been widely used to deposit very thin amorphous and pinhole free membranes whose chemical composition differs in a wide range of values. Usually, the plasma polymer obtained by PECVD technique looks like a conventional polymer but differs according to the cross linking. Indeed, in plasma polymers, there is no evidence of long chains and even though no local structuring of clusters at short distance. Changing the deposition parameters of the PECVD technique helps the user change the cross linking in a wide range.

CEA process and polymer, silicone and fluor-o-polymers films

Deposition of PDMS and Teflon-like films is performed by PECVD under RF (13.56 MHz) plasma activation. LF (400 kHz) plasma activation can also be encompassed to increase the sample bias voltage so to promote higher density films under ions bombardment effect. PDMS films are based on plasma polymerization where liquid PDMS oligomers (HMDSO and OMCTSO) vapours sustained at 55 °C are carried by a helium flow to the reaction chamber. Oxygen-free processes are used to synthesize SiOC hydrophobic films (dep. rate ~1 nm/sec) while oxygen-rich processes are used to synthesize SiOx hydrophobilic films (dep. rate ~5 nm/sec). Teflon-like films are plasma polymerized using gaseous C4F8 precursor. In any case processes are carried out at low temperature (< 100 °C) and mild plasma power (< 1 kW) to preserve heat sensitive substrate materials.

Typical structures and designs:



CEA in-house built PECVD apparatus

Special features:

- Si wafer processing PECVD type / Cylindrical design / Stainless steel and aluminium
- Pressure used from 0.1 to 10 mbar
- Plasma power < 2W/Cm² (max 6 W/Cm²)
- Plasma type : capacitive with parallel plates (showerhead and substrate holder)
- Gas inlet by showerhead 200 mm diameter

Limitations, constraints:

- Chamber walls heated to 55°c
- HMDSO / OMCTSO limited < 100 sccm He bubbling

Material examples:

- Si
- Stainless steel
- Aluminium
- And others…

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Surface nanotexturation
(Nano-beads self-assembly)

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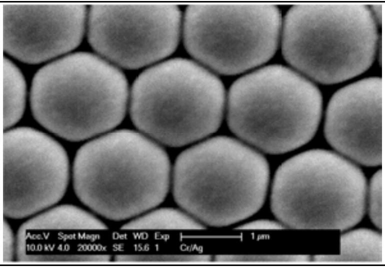
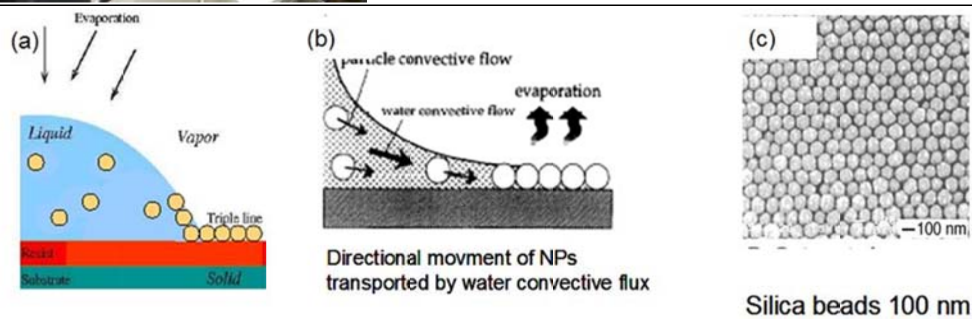
<table>
<tr><td>Contact:</td><td colspan="7">Pascal Fugier
Email pascal.fugier@cea.fr • Phone +33(438)782876</td></tr>
<tr><td>Material class:</td><td>Silicon
X</td><td>Polymer
X</td><td>Metal
X</td><td>Ceramic</td><td>Glass</td><td>Organic</td><td>Other</td></tr>
<tr><td>Short technology description:</td><td colspan="7">The method relied on the direct evaporation of a droplet of a colloidal solution on the surface and was called Capillary Force Assembly (CFA). The nano-particles dragged by the convective flux in the droplet were forced to assemble on the surface close to the liquid meniscus.
This approach where the assembly is monitored by both the capillary forces at the liquid meniscus and the surface patterns as Directed Capillary Assembly (DCA).</td></tr>
<tr><td rowspan="3">Typical structures and designs:</td><td colspan="7">
Microspheres self assembling</td></tr>
<tr><td colspan="7">
Nanospheres self assembling tool by nanometrix</td></tr>
<tr><td colspan="7">

Principle of the capillary force assembly</td></tr>
<tr><td>Special features:</td><td colspan="7">– Large size of substrate
– Coating mode horizontal and also vertical
– Large choice solvents</td></tr>
<tr><td>Limitations, constraints:</td><td colspan="7">– Size balls > 50 nm</td></tr>
<tr><td>Material examples:</td><td colspan="7">– Plastics balls
– Glass balls
– Polystyrene balls</td></tr>
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