GDP CAPSULE WITH CONTROLLED ROUGHNESS FOR TURBULENCE LASER EXPERIMENTS

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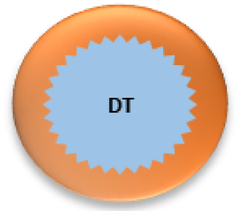
Context

In prevision of future experiments at the Laser Mégajoule (LMJ) facility dedicated to the study of turbulence phenomena during implosion of a DT target, we develop a hydrogenated amorphous carbon (a-C:H) capsule with a controlled roughness on its inner surface. To achieve this goal, we use a plasma treatment to etch outer surface of a poly-α-methylstyrene (PAMS) mandrel in order to degrade its roughness. The second step consists in synthetizing a plasma polymer (GDP) on this rough surface before the thermal removal of the PAMS mandrel.

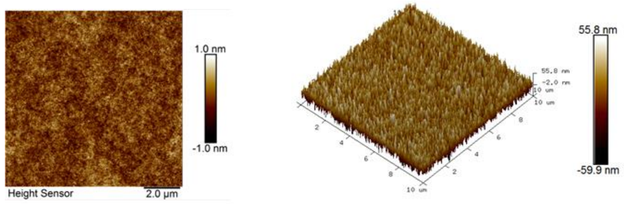


GDP capsule with a controlled roughness on its inner surface

Plasma furnace study

In order to validate this approach, we have first studied the effect of a plasma treatment obtained with a plasma furnace on PAMS thin films deposited onto a silicon wafer. Roughness of the sample is therefore measured by an atomic force microscope.

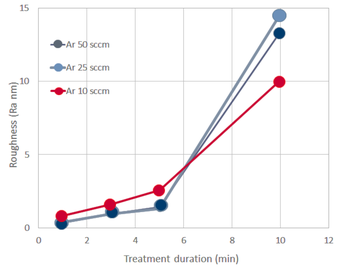
Plasma furnace

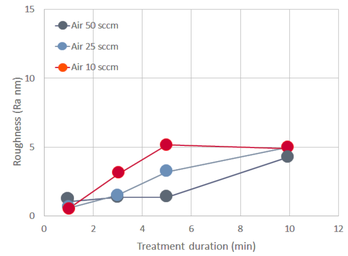


Examples of AFM scanning of a PAMS coating before (left) and after (right) a plasma treatment under argon

A significant degradation of the PAMS roughness is observed after only a few minutes under an argon plasma. The etching process is random and therefore the roughness is found to be uniform on the surface of the treated sample.

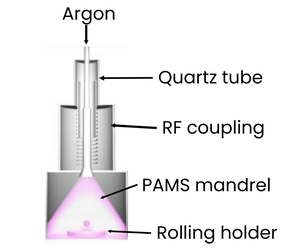
This study was performed with different etching gas (argon, air) and under different treatment conditions (pressure, RF power and duration).



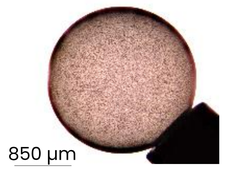


The arithmetic average roughness increases with time under argon plasma. By opposition in case of air treatment the Ra value stays around five nanometers independently of treatment duration.

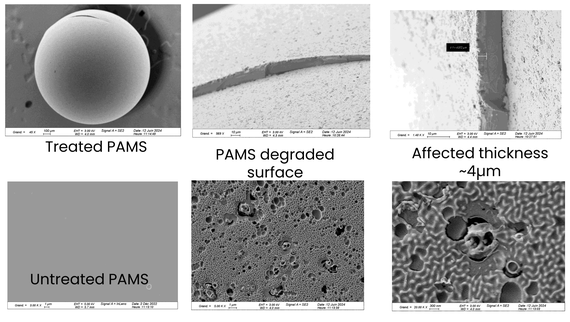
Plasma treatment on PAMS mandrel



GDP coater modified for plasma treatment

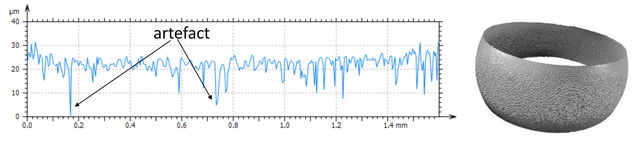


Example of PAMS after argon treatment in a GDP coater



The polymer surface has two kinds of porosity: one is randomly distributed on the surface and composed of micrometer holes and the second one at a nanometer scale is present over the entire surface of samples. The origin of microholes is maybe due to the interaction between the polymer and the substrate holder during the rolling movement.

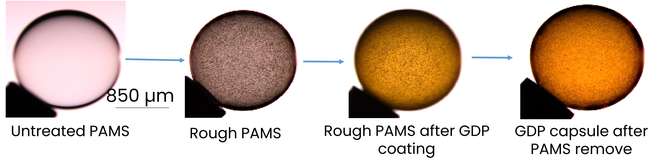
Roughness measurement on PAMS

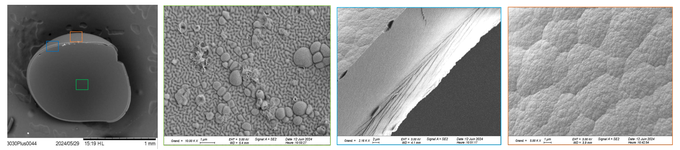


Examples of profile and 3D reconstruction obtained with an optical profilometer along an equator of a treated PAMS

An arithmetic average roughness from several hundred nanometers to few micrometers can be obtained by adjusting treatment parameters (RF power, working pressure and duration).

Roughness transfer from outer PAMS to inner GDP surface





Microstructures observed on inner surface of GDP capsule are similar to those obtained previously on PAMS surface.

Rough inner surface does not affect the microstructure of the GDP layer and its external roughness as shown on the pictures of the slice and the surface of the GDP capsule.

Conclusion and perspectives

We demonstrated our capability to synthetize GDP capsule with a rough inner surface. This result was achieved by developing a surface treatment under argon in a GDP coater in order to degrade the roughness of PAMS mandrel. Rough GDP capsule was obtained without consequences on its microstructure and on its external surface roughness that are similar to a classical GDP capsule. Roughness measurement needs to be consolidated in order to adjust plasma treatment parameters and to allow measurement of several equators of the same mandrel to associate a power spectrum to this kind of capsule. Furthermore, the possibility of measuring the roughness through the GDP layer by a non-destructive method is also a challenge to overcome.

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