MODIFICATION OF THE POLYURETHANE FILM SURFACE PROPERTIES AFTER AIR-PLASMA TREATMENT

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Introduction

One of the most powerful methods to modify the polymeric proprieties is plasma treatment, because the changes are made only at the surface, without altering their bulk characteristics. The plasma treatments are used to modify surface hydrophobicity/hydrophilicity so that cells adhere to the surface of the polymer [1]. In this work, the influence of the air plasma treatment on the hydrophilicity and surface roughness of a polyurethane film with siloxane sequences was studied.

Experimental

The polyurethane film is based on polycaprolactone (PCL), polybutylenadipate diol (PBA),4,4`-diphenylmethane diisocyanate (MDI), 1,4-butane diol (BD) and polydimethylsiloxane diol (PDMS) (Fig.2 (a)). Briefly, the plasma treatments were performed in air with an EMITECH RF plasma device at 5 min and 5 W without affecting the polymer bulk (Fig2.b). Films roughnesses were determined using a Tencor Alpha-Step D-500 stylus profiler (KLA Tencor Corporation, Milpitas, CA, USA (Fig.1). Images were recorded using a confocal Raman microscope spectrometer (Renishaw plc, Gloucestershire, UK) inVia, equipped with a Leica DM2700 microscope with 5x, 20x and 100x lenses (Fig.1).

Results

Several studies have indicated that the surface wettability and roughness proprieties of the polymers are key factors in cell adhesion [2,3].Generally, a moderate wettability is more able to bind cells in comparison with very hydrophilic or hydrophobic surfaces [4].

The reported **contact angle measurements** of our samples showed a contact angle of 81.71 for neat PU and 74.71 for PU treated (Table 1). Hence, the PU treated with plasma showed an improvement in the hydrophilic character than the neat polyurethane. The decrease of the contact angle value is in accordance with the slight increase of the cell viability, as was observed in biological test (Fig.4).

Regarding the **roughness parameters** measured with profiler it was revealed that the treatment time causes an increase of the surface roughness parameters (Table 1, Fig.3), values found by other authors in the literature for the polyurethane membranes[5]. **Raman images** were taken from different parts of the surfaces in order to see the differences of the samples roughness. After the plasma treatment the surface morphology has a rougher appearance than before (Fig.1).

Conclusions

The surface wettability and roughness play an important role in cell adhesion and proliferation. Hence, the polyurethane sample after the air plasma treatment showed an increased in hydrophilic character than the neat polyurethane. The roughness morphology of the treated polyurethane sample is changed and the values parameters of the average square roughness (R_a) are increased. The cytotoxicity assay test has better results after the plasma treatment in order to use this material in the medical field.

References:

[1].O.Nedela, P.Slepicka,V. Svorcik, *Materials*.10, 1115, 2017
[2]K.Webb, V. Hlady, P.A. Tresco, *J. Biomed. Mater. Res*. 41, 422–430,1998
[3]M.Ferrari, F.Cirisano, M.C. Moran, *Colloids Interfaces*. 3, 48, 2019
[4]L.Chen, C.Yan, Z.Zheng, *Mater. Today* . 21, 38–59, 2018.
[5]M.Shahrousvand, G. M. M.Sadeghi, E. Shahrousvand, M. Ghollasi, A. Salimi, *Colloids Surf. B*, 156,292-304, 2017.

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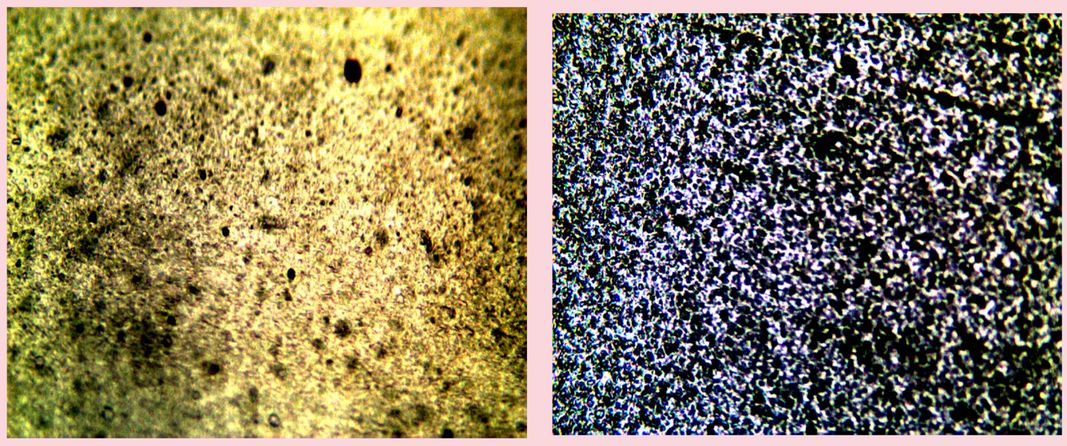
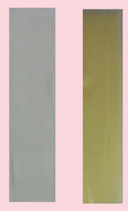


(a) (b)

Fig 1. Raman image at 20x µm obtained by Raman spectroscopy measurements (a) Polyurethane neat (b) Polyurethane treated in air plasma 5 min 5 W



(a) (b)

Fig.2 (a) PU neat film (b) PU film treated in air plasma 5 min 5 W

Tabel 1. Surface roughness and wettability results

Samples	Roughness	Contact Angle Parameters
	R_a (nm)	Θ_W
PU neat	388.72±0.10	81.17±0.12
PU treated	436.38±0.15	70.71±0.17

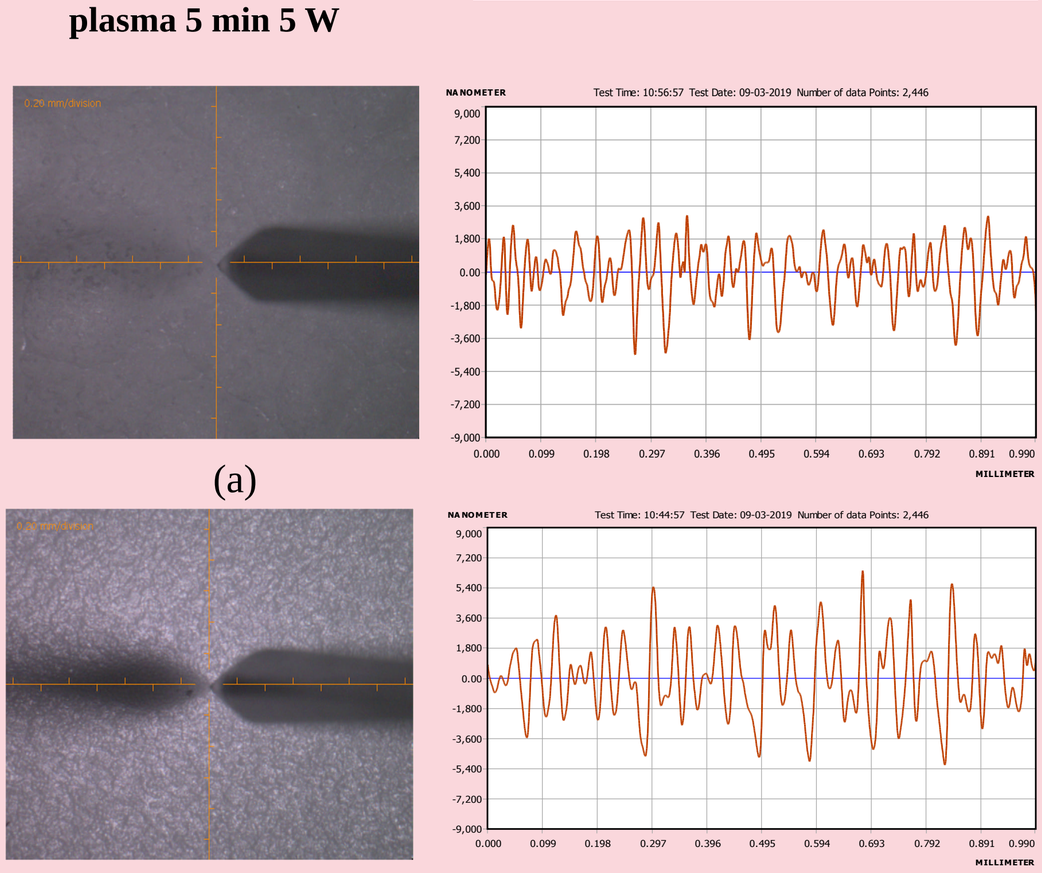


Fig 3. Profiler of the roughness measurements of samples R_a (a) PU neat (b) PU treated with air plasma at 5 min 5 W

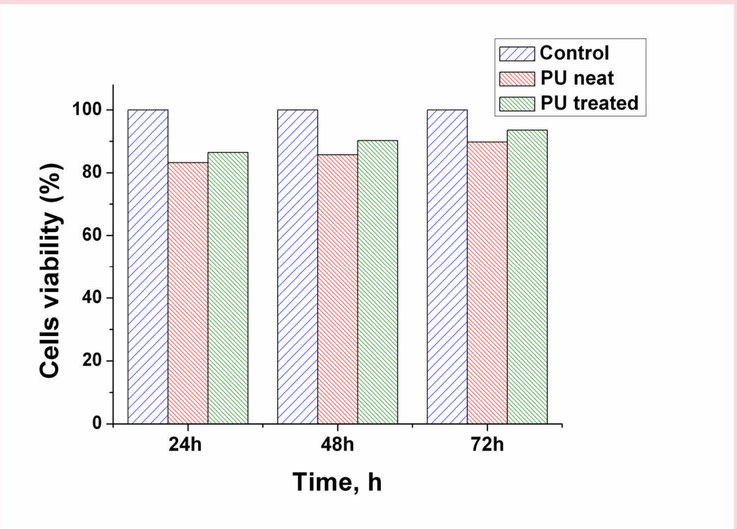


Fig 4. MTT assay of PU neat and PU treated