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Influence of silver nanoparticles on fibronectin adsorption at the surface of a plasma-deposited organosilicon coating

Laurine Martocq*, Pascale Chevallier¹, Morgane Laurent¹, Gaétan Laroche², Kremena Makasheva³

¹Centre de recherche du CHUQ, ²Laval University, Quebec, Canada, ³Paul Sabatier University, Toulouse, France

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Introduction: At any given time, out of 100 hospitalized patients, 7 in developed and 10 in developing countries will get at least one healthcare-associated infection (HCAI). The development of HCAIs is mainly due to the material's surface colonization by microorganisms. Adherent bacteria organize themselves to form a biofilm, once the extracellular polymeric matrix made of proteins, polysaccharides, and lipids is formed [1]. The biofilm structure renders the bacteria highly resistant to antibiotics, and accordingly, there is a growing need to develop new strategies to inhibit this bacterial structuration. This project takes advantage of the known antimicrobial potential of silver nanoparticles (AgNPs) [2]. However, to achieve a long-lasting delivery of Ag⁺ ions, fast oxidation of the AgNPs should be avoided. Protection of the AgNPs was ensured through coating with a plasma-deposited organosilicon matrix [3,4]. This study focuses on the adsorption of fibronectin (FN) at the surface of plasma-deposited organosilicon (SiOC:H) surfaces containing AgNPs, as the protein adsorption is the first step towards bacterial biofilm formation.

Experimental methods: An axially-asymmetric radiofrequency capacitive plasma was used to deposit a SiOC:H matrix and AgNPs on quartz substrates (<10 Pa). The matrix was obtained using a gas mixture of hexamethyldisiloxane (HMDSO) and argon, while the AgNPs were synthesized by sputtering of the upper silver electrode in an argon plasma. Droplet of 10 µL of human FN solution in HEPES buffer at a concentration of 200 µg/mL, were deposited on the plasma-deposited SiOC:H surfaces with or without AgNPs. The adsorption lasted for 1h and was followed by 3 successive washings in water with vortex and drying. Atomic Force Microscopy (AFM), X-ray Photoelectron Spectroscopy (XPS) and dynamic contact angle measurements were used to characterize the surfaces and the FN organization after adsorption.

Image:

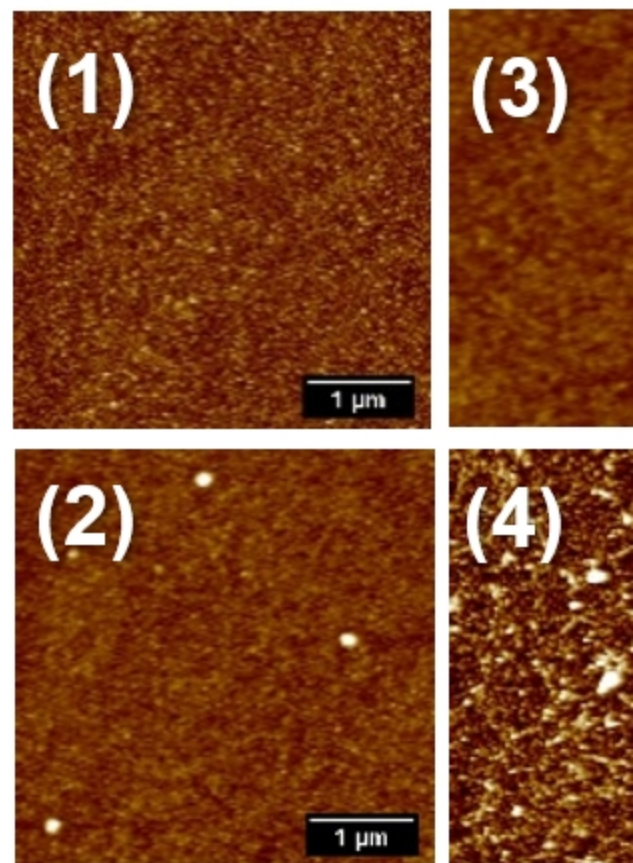
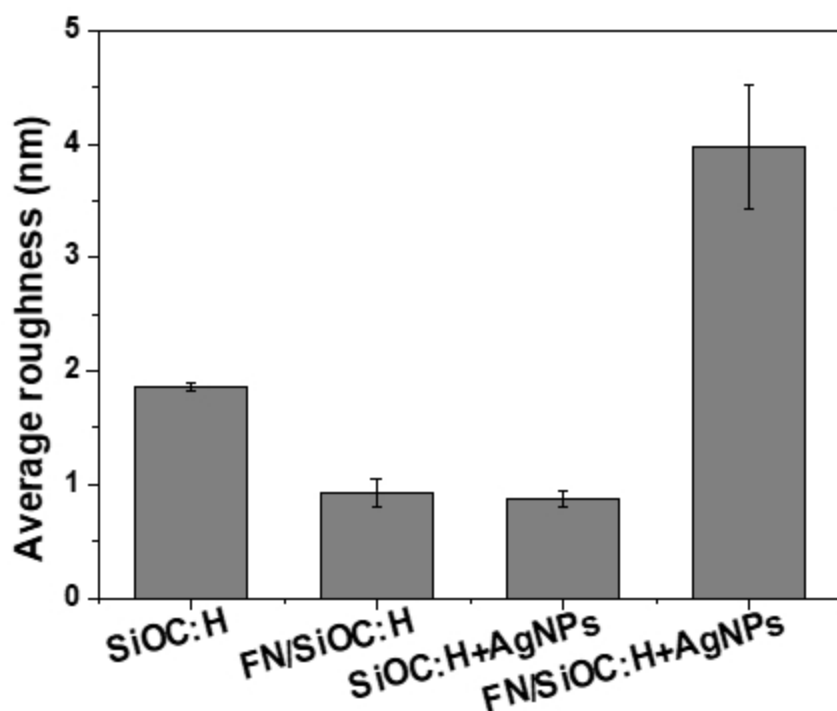


Table:

Sample	Elemental composition (%)				
	O	Si	C	Ag	N
SiOC:H	36.9	16.1	46.4	-	-
FN/SiOC:H	20.6	7.2	61.2	-	11.0
SiOC:H+AgNPs	30.4	14.6	45.7	3.4	-
FN/SiOC:H+AgNPs	20.1	4.5	62.9	2.8	9.6

Results and discussions: XPS spectra (Table 1) clearly put in evidence the presence of Ag, and adsorbed FN through the presence of N1s feature, characteristic of proteins, while no N1s peak was detected on the plasma-deposited SiOC:H and SiOC:H+AgNPs thin films. FN adsorption was further confirmed by the decrease of %Si and %Ag with the amount of adsorbed FN. Moreover, the difference of %N between the FN/SiOC:H and FN/SiOC:H+AgNPs suggested either a modification in the FN organization or in quantity of adsorbed FN influenced by the AgNPs. AFM images confirmed also the presence of adsorbed FN by modification of the roughness (Fig.1). Moreover, the difference of roughness between FN/SiOC:H (2) and FN/SiOC:H+AgNPs (4) showed that the AgNPs influence the FN adsorption leading to a conformation in contact to the surface.

Conclusions: XPS spectra and AFM images confirmed the presence of Ag and adsorbed FN on the surfaces. These analyses suggested also a modification of the protein organization or in the quantity of proteins after adsorption on the surface of thin organosilicon films containing AgNPs. Finally, ELISA tests will be used to identify the availability of the specific sites (RGD) of the protein.

References/Acknowledgements: [1] M. Habash, and G. Reid, J. Clin. Pharmacol. 39 (1999) 887-98. [2] M. Rai, *et al.*, Biotechnol. Adv. 27 (2008) 76-83. [3] B. Despax, and P. Raynaud, Plasma Process. Polym. 4 (2007) 127-134. [4] K. Makasheva, *et al.*, IEEE Trans. Nanotechnology 15 (2016) 839-848.
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