Coatings for Biomedical and Healthcare Applications
Room Pacific D - Session D3-TuA

Biointerfaces: Improving Cell Adhesion and Avoiding Bacteria. What Kinds of Coatings Should be Used?

Moderator: Danieli B.C. Rodrigues, University of Texas at Dallas, USA

1:40pm **D3-TuA-1 Enhanced Mechanical Properties and Microbiological Behavior of a Ag-C:H Coating Produced by Reactive pDCMS**, *N. Fukumasu,* ***Pâmella Esteves (pamellaesteves@usp.br)****, V. Malaquias,* University of São Paulo, Brazil*; E. Prados,* Federal University of ABC, Brazil*; M. Hirata, A. Tschiptschin, I. Machado, R. Souza,* University of São Paulo, Brazil

Surfaces presenting antimicrobial activity became more relevant during the COVID-19 outbreak, in which restricting the spread of virus and bacteria agents become important in crowded places, such as hospitals and public transportation. Literature reports the use of metallic coatings, such as silver and/or copper, promote excellent antimicrobial activity but present lower adhesion and mechanical properties, mainly when compliant substrates are used. Nanocomposite coatings based on silver and carbon may be applied to improve such characteristics, preserving the antimicrobial activity. The deposition of carbon coatings, using physical vapor deposition techniques, may require high substrate temperature (>200ºC) for long periods of deposition time (>1h), which is not suitable for overall polymer substrates. In this work, the pulsed direct current magnetron sputtering (pDCMS) technique was applied to produce Ag-C coatings on PMMA-based substrates. High purity silver and carbon targets were used to produce Ag and Ag-C coatings using Ar as plasma gas. In addition, a mixture of Ar+H allowed the production of Ag-C:H coatings. The mixture of Ar+H was applied only during the carbon deposition phase to enhance the coating growth rate and promote additional features, including a higher degree of sp_3 carbon bonds, which improves mechanical properties. All coatings were analyzed using Raman spectroscopy, XPS, instrumented indentation, scratch test, SEM+EDS and microbiological tests (*E. Coli* and Sars-CoV-2). Results indicate that Ag-C coatings presented an increase in hardness and substrate adhesion, but lower antiviral and bactericidal activity when compared with pure Ag coating with similar thickness. Nevertheless, the use of Ar+H mixture, in which H_2 acted as a reactive gas during the deposition of the amorphous carbon, resulted in an Ag-C:H coating with higher mechanical properties while presenting improved antiviral and bactericidal effects than pure Ag coating.

2:00pm **D3-TuA-2 Coating of Titanium Surfaces with Silver-Chitosan using Silane Linkers**, ***Emily Coleman (cclman22@memphis.edu)****, E. Abuhussein, M. Edwards, J. Bumgardner, J. Jennings,* University of Memphis, USA

Titanium implants and instruments are widespread in the field of orthopedics due to the material's strength, resistance to corrosion, and bone-like mechanical properties. Silver ions have broad spectrum antimicrobial properties against bacteria and fungi and thus are advantageous as an implant coating in combination with chitosan biopolymer. Previous titanium coating attempts with chitosan-silver solutions gave weak adherence to the substrate and removal of the coating after contact with saline. In the current study, methods were demonstrated for attaching chitosan-silver conjugates to titanium using silane linkers to increase stability and adherence of the coating. Titanium coupons were polished and sonicated in soapy water to remove oil and residue, then in acetone and ethanol. The coupons were covered in sodium hydroxide (5 M) for 24 hours at 60°C to allow the titanium surface to accumulate hydroxide reactive groups. After rinsing with deionized (DI) water, the coupons were immersed in a 95% (v/v) ethanol solution (pH = 4.5). Using a nitrogen environment glove box, the silanization agent was added to create a 2% (v/v) silane solution in ethanol. Non-adhered silane was removed with ethanol, and coupons were dried at 110°C for 10 minutes before addition of chitosan silver (Chitozan Health, LLC). After drying overnight, coupons were immersed in phosphate buffer for 1 hour before rinsing with DI water and drying fully. To evaluate the bonding strength between the titanium coupons and the chitosan coating, Instron mechanical testing with a custom fixture was performed on coupons that were glued to pegs using GorillaWeld Steel Bond Epoxy Two Part Adhesive. Electron dispersive spectroscopy (EDS) was used to evaluate the success of the coating process by determining the presence of silver after 24-hour aqueous exposure. The mechanical testing suggested that the coating process was successful, and coating-adhesive strength exceed the adhesive strength of the glue-peg interface. EDS results indicated that the amount of silver on the surface of silanated coupons (10-15%) was significantly greater than non-silanated coupons (<1%), and the silver was homogenously distributed on the silanated coupon surface (**Figures 1 and 2**). Overall, results suggest that the silanation procedure for coating titanium surfaces promotes retention of silver on the titanium surface. Further studies are planned to assess the antimicrobial efficiency over time and human cell compatibility of the coatings. Coating strategies could be implemented with many application methods including dip coating, solution casting, electrospraying, and electroplating.

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