Coatings for Biomedical and Healthcare Applications
Room Golden State Ballroom - Session DP-ThP

Coatings for Biomedical and Healthcare Applications (Symposium D) Poster Session

DP-ThP-3 Antimicrobial and Aging Properties of Ag-, Ag/Cu- and Ag Cluster-Doped Amorphous Carbon Coatings Produced by Magnetron Sputtering for Aerospace Application*, G. Sanzone, J. Yin,* ***Hailin Sun (hailin.sun@teercoatings.co.uk)****,* Teer Coatings Ltd, UK

Inside a spacecraft, the suitable temperature and humidity, designed for onboard human crew, also creates an ideal breeding environment for the proliferation of bacteria and fungi, which can present hazard for both the safety running of equipment and human health. To address this issue, it is proposed to coat the key parts and components with wear-resistant antimicrobial thin films prepared by magnetron sputtering. Silver and copper are among the most studied active bactericidal materials for a long history. In this work we investigate the antibacterial properties of silver doped, silver-copper doped, and silver cluster doped amorphous carbon coatings for aerospace applications and their longevity, which is heavily influenced by the metal diffusion rate to the coating surface. Samples have been prepared with different silver and copper volume fractions via co-sputtering, while Ag cluster samples are prepared using a cluster source to better control the metal particle size distribution in the amorphous carbon coating matrix. Antibacterial tests are performed under both terrestrial gravity and microgravity conditions, to simulate the condition in the space. Results show that silver doped coatings are very effective in terms of antimicrobial property but with a faster silver atom diffusion, while those silver-copper doped samples have generally a slightly lower antimicrobial activity, but no obvious metal diffusion observed. For the silver cluster doped samples, they show a high antimicrobial activity despite a much lower silver volume fraction, and a seemingly slow Ag metal diffusion rate.

DP-ThP-4 Structure and Mechanical Properties of Superelastic TiZrNb and TiSnZrNb Coatings for Biomedical Applications*, T. Choquet, A. Fillon,* Institut des Sciences Chimiques de Rennes, France*; A. Michel,* Institut Pprime - CNRS - ENSMA - Université de Poitiers, France*; M. Vayssade,* Université de technologie de Compiègne, France*; T. Gloriant,* Institut des Sciences Chimiques de Rennes, France*;* ***Gregory Abadias (gregory.abadias@univ-poitiers.fr)****,* Institut Pprime - CNRS - ENSMA - Université de Poitiers, France

Titanium alloys are propitious materials in biomedical implants for their mechanical properties and biocompatibility. Nitinol (Ni-Ti), especially, has been used because of its superelasticity (up to 12% recoverable strain) due to a reversible martensitic transition. Ni, however, has been proven allergenic and so in the past decade, research has focused on β-type titanium alloys with non-toxic and non-allergenic elements such as Nb, Sn, Ta or Zr with the aim of replacing Ni-Ti. In this study, novel coatings based on ternary and quaternary titanium alloys have been elaborated. Their properties have been studied for bulk materials; however, the structural and mechanical properties for their thin film counterpart remain to be elucidated, which is the aim of the present study.

Ti-Nb-Zr and Ti-Nb-Zr-Sn coatings have been elaborated at room temperature by magnetron sputtering at a working pressure of 0.26 Pa. By using different targets and by changing the power applied to them during deposition, different chemical compositions have been obtained, with Nb content ranging from 0 to 33 at.%. The focus has been on identifying the crystallographic structure and the mechanical properties of the films depending on their chemical composition. XRD, TEM and resistivity measurements were performed to study the phase formation with respect to the Nb content. The stress induced during film growth has been evaluated *in-situ* using wafer curvature measurements and the mechanical properties were evaluated using nano-indentation and tensile tests. To assess the biocompatibility of the films, early cell behavior (cell adhesion, spreading and morphology) will be characterized and standardized cytotoxicity assay will be conducted.

Using XRD θ/2θ scans, the films have been found to be highly textured: the main peaks are 002 α and 110 β. XRD, TEM and resistivity show that with increasing Nb and Zr content, the phase evolves from hexagonal α phase to orthorhombic α'' martensite and then to cubic β phase. The curvature measurements have shown that at low Nb content, the film first develops a compressive stress that evolves during continuing growth into tensile stress. At high Nb content, the stress remains compressive throughout deposition. Preliminary *in vitro* biocompatibility tests show that osteoblast cells well adhere on the quaternary coatings after 72 h and manifest cell functional activity.

DP-ThP-5 Development of Multilayer Hydroxyapatite (HA) - Silicon (Si) Coatings Deposited on Ti6Al4V by Magnetron Sputtering with Potential Biomedical Application*,* ***Julián Andrés Lenis Rodas (julian.lenis@udea.edu.co)****, K. Perez Zapata, F. Bolívar Osorio,* University of Antioquia, Colombia*; P. Rico, J. Gómez Ribelles,* University of Valencia, Spain

Titanium alloys, specifically Ti6Al4V, are widely used in the biomedical field because they have an adequate balance between mechanical properties, corrosion resistance and biocompatibility. However, when it is incorporated into the human body, unfavorable reactions can be obtained that do not allow adequate osseointegration, due to the formation of a fibrous and non-adherent layer between the biomaterial and the bone, which can trigger the failure or rejection of the implant. The purpose of this study was to evaluate the influence of the surface modification of Ti6Al4V with a Hydroxyapatite (HA) - Silicon (Si) coating on its in vitro biological response, also studying the effect of surface roughness. The deposition process was carried out by Magnetron Sputtering on Ti6Al4V surfaces with different roughness - RMS, 3.8 nm and 48.7 nm. The surface morphology of the coatings was observed by Scanning Electron Microscopy and Atomic Force Microscopy, the chemical composition was evaluated by means of EDS and micro-Raman spectroscopy. The biological response of the coatings was evaluated by MTT and cell adhesion assays, using mouse mesenchymal stem cells. The control in the process parameters allowed to obtain coatings with a good compositional balance (a Ca/P ratio close to 1.67 and characteristic vibrations of HA). RMS values of 27 ± 5 nm and 52 ± 6 nm were obtained for the coatings obtained on the Ti6Al4V with different roughness. The biological tests indicated a non-toxic behavior in the HA-Si coatings, in addition, the cellular adhesion of the Ti6Al4V was favored both by the incorporation of this system and by increasing its roughness.

DP-ThP-6 Effective Antiviral Copper Coatings onto Thermoplastic Against SARS-CoV-2*, C. Popescu,* IRCER, France*; M. Courant,* CHU Limoges, France*; E. Laborde,* IRCER, France*; S. Alain,* CHU Limoges, France*; V. Perin,* Kometa Technologies, France*; A. Castro,* CITRA, France*; L. Youssef,* IRCER, France*; T. Maerten,* Oerlikon-Balzers, France*;* ***Marjorie Cavarroc (marjorie.cavarroc@safrangroup.com)****,* Safran, France*; D. Alain, A. Vardelle,* IRCER, France

The actual viral outbreak continues to have a tremendous impact on human health, social relations, and the economic situation worldwide. Eengineered metallic coatings can mitigate the viral transmission from the thermoplastic surfaces (fomites) touch points in transports. This goal is achievable by functionalizing thermoplastic surfaces with metals through innovative designs that inhibit or destroy the microorganisms. The life span of these functionalized surfaces depends on their physical-chemical properties and external factors (e.g., humidity, temperature, cleaning agents, etc.) that can modify the engineered surface. The presented work focus on copper-based thermoplastic surfaces obtained by different deposition methods to observe the influence of the chemical composition of the surface, but also the importance of coating structure and texture, to increase the SARS-CoV-2 inactivation rate. The in-vitro antiviral tests are realized in agreement with normalized protocols to qualify the antiviral surfaces (ISO 21702:2019). The obtained results show that the deposition method has a strong influence on both the microstructure and the surface chemistry of the engineered Cu films. The coatings enhanced grain dislocations increase the Cu ions release and their participation in the reactive oxidative species processes influences the viral growth time.

DP-ThP-7 Antibacterial Graphene Coatings Electrophoretically Deposited on Nitinol Substrate*,* ***Madhusmita Mallick (madhusmita1509@gmail.com)****, K. Mitra, A. N,* Indian Institute of Technology (IIT) Madras, India

Graphene can be an effective antibacterial candidate owing to its bactericidal property. In this study, graphene coatings were prepared on Nitinol substrate through a cost-effective electrophoretic deposition method (EPD). The antibacterial activity of graphene-coated samples was investigated against two strains of gram-positive (S.Aureus) and gram-negative (E.Coli) bacterias by classic colony counting method, live/dead fluorescent microscopy and scanning electron microscopy (SEM) techniques. Here, bare nitinol substrate was chosen as a control sample.The results showed that the coatings exhibited stronger antibacterial activity against E. coli bacteria with thin membrane than S.

aureus bacteria with thick membrane. Furthermore, the antibacterial test suggested that oxidative stress mechanism is the main factor of antibacterial activity of EPD prepared graphene coatings.

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