Coatings for Biomedical and Healthcare Applications
Room Pacific Salon 2 - Session D1-1-MoM

Surface Coating and Modification for Use in Biological Environments I

Moderator: Mathew T. Mathew, University of Illinois College of Medicine at Rockford and Rush University Medical Center, USA

10:20am **D1-1-MoM-2 Very Thin Gold Films Deposited on Collagen Fabric for Skin Cell Recover***, **Sheng-Yang Huang**,* Taichung Veterans General Hospital, Feng Chia University, Taiwan*; Y Chang,* Feng Chia University, Taiwan*; P Hsieh,* Institute of Plasma, Feng Chia University, Taiwan*; C Chou,* Taichung Veterans General Hospital, National Yang-Ming University, Taiwan*; C Chung,* Central Taiwan University of Science and Technology, Taiwan*; J He,* Feng Chia University, Taiwan

The goal of this study is to develop a novel biomedical material, where gold thin film is deposited on collagen fabrics for skin tissue engineering. Type I Collagen had been used in many products for its biocompatibility and critical role in skin recovery. Gold, in the form of nanoparticles (AuNPs), had been proven to improve biomaterial properties, such as mechanical strength, elasticity, degradation resistance, cell attachment, cell proliferation and wound healing. Unlike chemically prepared AuNPs in most of present literature, very thin gold films deposited by high-power impulse magnetron sputtering (HIPIMS) on collagen fibers reveal the advantage of green synthesis process and free from chemical ligand of gold particles.

Scanning electron microscopy (SEM) and X-ray diffraction (XRD) are used to observe the surface morphology and microscopic characteristics of the composites. Fourier transform infrared spectroscopy (FTIR) and circular dichroism spectroscopy (CD) are used to evaluate functional groups and secondary structure of collagen, respectively. Process of biomedical fabrics with collagen and gold thin film in different thickness is established.

Keywords: gold thin films, HIPIMS, collagen fabric, skin cell recovery

10:40am **D1-1-MoM-3 Effect of Calf Serum on Tribological Behavior of DLC Coating in Ti-6Al-4V / Ti-6Al-4V Contact for Application to STEM / NECK Contact of Modular Hip Implant***, H Ding, **Vincent Fridrici**, G Bouvard,* Ecole Centrale de Lyon, LTDS - Université de Lyon, France*; J Géringer,* Ecole des Mines de St-Etienne - Université de Lyon, France*; P Kapsa,* Ecole Centrale de Lyon, LTDS - Université de Lyon, France

Influences of new-born calf serum on the fretting behaviors of Ti-6Al-4V and diamond-like carbon coating were investigated using a fretting-wear test rig with a cylinder-on-flat contact. The results indicated that, for the Ti-6Al-4V / Ti-6Al-4V contact, the friction coefficients were high (0.8-1.2) and the wear volumes presented an increase with the increase in the displacement amplitude under dry laboratory-air conditions. Under serum-liquid conditions, the Ti-6Al-4V / Ti-6Al-4V contact presented significantly larger wear volumes under the displacement of ±40 µm; however, it presented significantly lower friction coefficients (0.25-0.35) and significantly smaller wear volumes under the displacement of ±70 µm. The opposite effects of lubrication and corrosion are studied and analyzed. For the DLC coating / Ti-6Al-4V contact, the coating response wear maps could be divided into two areas: the coating working area (low normal force conditions) and the coating failure area (high normal force conditions). In the coating working area, the DLC coating could protect the substrate with low friction, low wear volume, and mild damage in the coating. The presence of serum had a positive influence on the tribological performance of the DLC coating. Furthermore, the positive influence was more significant under larger displacement amplitudes condition.

11:00am **D1-1-MoM-4 Accelerated Tests for Lifetime Prediction of Interlayers and Interfaces of Coated Implants in Body Fluid***, **Roland Hauert**, E Ilic, A Pardo-Perez, K Thorwarth, P Schmutz,* Empa - Swiss Federal Laboratories for Materials Science and Technology, Switzerland*; S Mischler,* Institut des Matériaux IMX, EPFL, Lausanne, Switzerland **INVITED**

Hard coatings such as diamond like carbon (DLC) on articulating joints can result in desired surface properties showing extremely low wear. However, an interlayer material or a single row of contamination atoms at the coating/substrate interface can result in altered corrosion behavior and possible adhesion instability. A method to determine the chemical composition of the few atomic rows of altered material at an interface, buried under several microns of coatings, will be shown by low angle polishing down to less than 0.06 degrees (less than 1/1000 steepness). Corrosion effects such as crevice corrosion, which can cause coating delamination after some years in vivo, cannot be accelerated in simulator testing since it evolves only as a function of time in media. A new setup for accelerated crevice corrosion testing in body fluid, as well as preliminary results, will be presented. Furthermore, stress corrosion cracking and corrosion-fatigue can damage the few rows of reacted atoms present at an interface. By simulating in vivo conditions, we are developing an accelerated test to asses these deteriorating effects at the interface. First results of coating adhesion lifetime expectations, including the influence of small detrimental contaminations, will be shown.

11:40am **D1-1-MoM-6 Thin Film Metallic Glass Coating as an Effective Antiadhesion Coating for Platelet and Cancer Cells***, **Jinn P. Chu**,* National Taiwan University of Science and Technology (NTUST), Taiwan*; C Li, Y Chen, S Chyntara,* National Taiwan University of Science and Technology, Taiwan*; M Chen,* Mackay Medical College, Taiwan*; S Chang,* Mackay Memorial Hospital Tamsui Campus, Taiwan

The adhesion of platelet cells is viewed as a first step in thrombus formation, and cancer cell attachment can lead to cancer seeding. The amorphous structure of metallic glasses (MGs) is a new group of coating materials exhibiting excellent hydrophobicity and resistance to bacterial colonization, as well as relatively low coefficient of friction. In this presentation, we will report a study which has been published in *Surface and Coatings Technology*, Vol. 344, p. 312-321 (2018), describing the feasibility of utilizing $Zr_{53}Cu_{33}Al_9Ta_5$ thin film metallic glass (TFMG) to minimize the adhesion of various human cancer cells (breast cancer cell, colon cancer cell, and esophageal cancer cell), human and animal platelets. TFMG was respectively grown on glass substrates to a thickness of 200 nm using magnetron sputtering. TFMG was shown to reduce surface roughness of glass. The concentrations of all major ions released from the TFMG were well below toxic levels. TFMG surfaces were effective in increasing the contact angle of water, phosphate buffer saline and blood from different animal species. The application of TFMG to bare surfaces was shown to reduce the attachment area of human platelets by 77 % and that of pig platelets by 63%. TFMG also reduced the attachment of cancer cells by up to ~87%. These characteristics can be attributed to a low surface free energy of TFMG-coated surfaces (31.89 mN/m), which is far below that of bare glass (47.80 mN/m). These findings demonstrate the considerable potential of TFMG coatings in the fabrication of medical instruments aimed at preventing the adhesion of platelet and cancer cells.

12:00pm **D1-1-MoM-7 Improvement of Surface Properties of Nitinol Alloy through Deposition of Graphene by Electrophoretic Deposition Technique for Biomedical Applications***, **Madhusmita Mallick**, N Arunachalam,* Indian Institute of Technology Madras, India

The superelastic nature of biocompatible material nitinol & its alloys is utilized for the application of orthodontic archwires due to its ability to prevent strain localization & plastic deformation. However, they tend to wear over time due to continual contact with body fluids and release toxic metal ions (Ni^{2+}) into the body. In order to overcome this limitation smooth layers of graphene was deposited on Nitinol wires by Electrophoretic Deposition technique to improve its wear resistance and other mechanical properties.

The electrodeposited coatings were characterized by Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), X-Ray diffraction, Raman spectroscopy and Potentiodynamic polarization technique. Raman spectroscopy showed the presence of graphene & 2-D graphitic phase. Finally, a post deposition treatment was done to evaluate in-vitro bioactivity by Simulated Body Fluid (SBF) immersion test. The results showed that graphene coating onto Nitinol substrate improved anti-corrosion rate and anti-bacterial properties while reducing friction as compared to bare Nitinol wires.

Hence, this bioactive coating exhibited better mechanical strength, enhanced wear and corrosion resistance indicating high potential for biomedical applications.

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