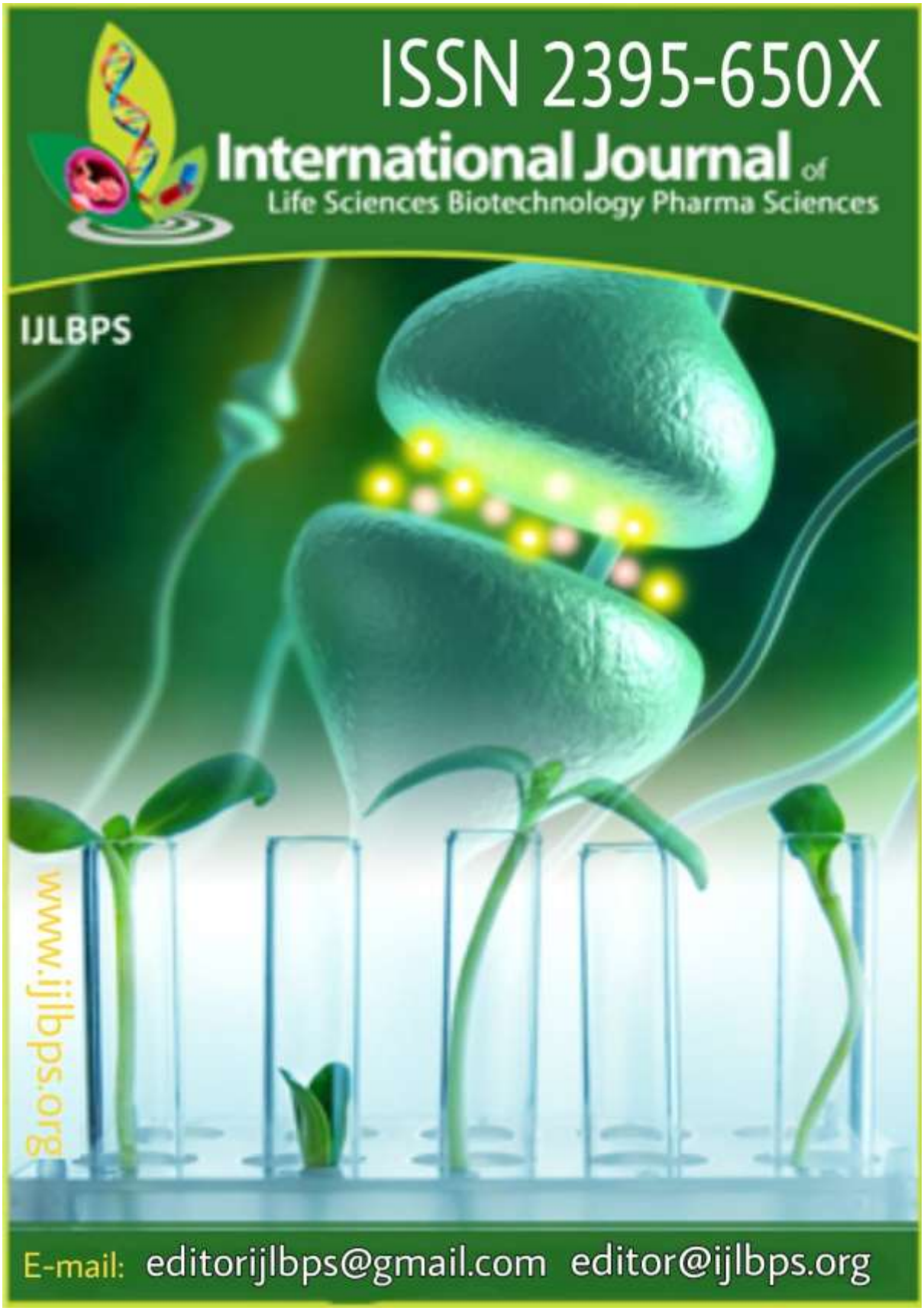
ISSN 2395-650X
International Journal of
Life Sciences Biotechnology Pharma Sciences
IJLBPS
www.ijlbps.org
E-mail: editorijlbps@gmail.com editor@ijlbps.org

International Journal of Life Sciences Biotechnology Pharma Sciences

Volume 9 Issue1 2021

A Review of Corrosion and Wear Properties on 316L Stain less Steel

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Abstract

A ball-on-disc tribometer was used to test the tribological behavior of 316L stainless steel under various typical loads in dry ambient air using an 85 percent cold rolling process and a subsequent annealing treatment (750 C, 10 min). Friction coefficients were shown to be lower and more stable in 316L stainless steel samples than in coarse-grained samples, especially at higher loads, which may be due to the presence of many oxidative particles at sliding interfaces. corrosion of 316L (UNS S31603) stainless steel expansion joints in the leaching solution of silt on blast furnace gas pipelines in an industrial power plant were studied. TA2's corrosion-resistant qualities indicate that it is the best material for the job. The available literature on various coating kinds and applications has been thoroughly and critically analyzed in this review work.

Keywords: corrosion, tribo-corrosion of 316L stainless steel, adhesion wear, abrasion wear, and oxidativewear;316Lstainlesssteel

1. Introduction

As the Greek word "Tribos" signifies rubbing, tribology is derived from this word, as well. All sections that come into contact with each other are covered. High load, high/low temperature, and harsh chemical environments are among settings where mechanical components have been used in various applications. However, wear is a problem that has been encountered in practically every industry.mechanical/moving components are involved.There are various materials used in modern dentistry that have unique properties in terms of their physical and chemical composition, as well as their aesthetic appeal. In dentistry, 316L stainless steel (AISI classification) is one of the longest-lasting materials on the market today. 316L stainless steel's corrosion resistance and mechanical qualities make it a good choice for shorttomedium-termprojects.

use in the body for a short period of time Dental 316L is most commonly used in orthodontics to create wires, brackets, and bands for orthodontic braces [2]. As a result of 316L's low price and low toxicity, it is a popular material for longer-term dental implants in underdeveloped countries.

2. Experimental

2.1. Coating preparation Unbalanced magnetron sputtering deposition in an Ar environment was used to produce the GLC coatings on the WC discs. Beijing Taimi Machinery Co., Ltd. developed the WC substrates with 30 mm x 30 mm x 5 mm dimensions. To achieve a final surface roughness of Ra1410–20 nm, diamond polishing was used on the working surfaces. As a result, the adhesion between Ti and WC substrates was much improved. As previously reported, the deposition was made public.

2.2. Coating characterization A scanning electron microscope was used to examine the microscopic features (SEM, Hitachi S- 4800). To test the mechanical properties, a nano-indenter was used (Nano Indenter II, MTS Ltd., US)

2.3. Tribological performances Areciprocating-typeball-on-disctribo-

meter(CSM,Tribo-S-D0000)wasusedtoinvestigate

In both dry and wet conditions, GLC coatings operate well on brass, aluminum, GCr15, titanium, and other metals. The mechanical properties of the four metallic analogues, all of which had the same diameter of 3 mm, were quite similar. Using the Hertz model for a ball on a flat surface [14,15], the maximum contact pressures were computed. At a load of 5 N, all of the tests were carried out. The greatest sliding speed was 7.86 cm/s and the reciprocating amplitude was 5 mm. Tribo-tests were carried out at least 20,000 times each. The friction coefficients (FCs) were automatically recorded. According to the equation K14V/SF [16], wear rates (WRs) of GLC coatings against different counterparts were determined using the wear volume of GLC coating, S is the entire sliding distance, and F is the normal load. A non-contact 3D (3-dimensional) surface profiler was used to estimate the volume losses of GLC coatings (MicroMAXTM, ADE Phase Shift, AZ US). Wear surfaces were also examined using JSM-5600 SEM, Raman spectroscopy, and electron probe microanalysis (EPMA) (EPMA).Corrosion

Many different solutions, including fake saliva, have been tested in recent investigations to study the micro-abrasion and corrosion mechanisms of type 316L stainless steel. To far, however, there are no research findings to support this.

2.4 Many different solutions, including fake saliva, have been tested in recent investigations to study the micro-abrasion and corrosion mechanisms of type 316L stainless steel. To far, however, there are no research findings to support this.

2.5 Surface Modification with the aid of grafts and implants Surface characteristics of bone implants can be efficiently modified using coating methods. In contrast, these coating methods create a barrier between the substance and its surroundings, preventing the organisms from communicating with each other. Because of this, many of the substrate's beneficial characteristics are rendered ineffective for the species surrounding it. Physically attached to a substrate, these coatings have a limited binding strength. It is possible to alter the physical and/or chemical properties of the surface by, for example, grafting molecules onto a surface or injecting anions into the substrate's superficial layer. Surface modification methods that do not involve the formation of a coating are described as "non-coating" methods in this section, along with other surface grafting procedures.methods and ion implantation techniques forthesurfacemodificationofboneimplantmaterialswillbeintroduced.Furthermore,thesenon-coatingtechniquesdonotmodifytopographic features in either micro- or nano-scale.

2.6 TotalWearThenon-linearrelationshipbetweenappliedloadandmicro-abrasionobserved in this study's results is consistentwith a previous study of 316L stainless steel inartificialsaliva[6].Otherrecentstudiesofdifferent materials and solutions suggest thatapplied electrical potential has no observableeffect on the rate of micro-abrasion [20]. Thisconclusion appears to be consistent with theresultsofthisstudysincethetotalwearofeach appliedloadisconstantforallappliedelectricalpotentials.whichdisplaysthemeantotalmicro-abrasionmasschangefor eachappliedloadwithastandarderrorshowingthewearvariation over all applied electrical potentials.The'error'showsaverylowvariationbetweenthe 5 applied electrical potentials. A standarderror for every electrical potential cannot begeneratedbecauseonlyabnormal(unreportable)testresults wererepeated.

2.7 ScanningElectronMicroscopy

A XL30 SEM microscope was used to conduct SEM measurements on the coated substrates' surfaces in order to determine the surface morphology.

Secondary and backscattered electron imageswerecollectedat 15 kV

3 MaterialsandMethods

3.1 MaterialsandSpecimens

3.2 For the alloyed material employed, which is to say the substrate material, AISI 316L austenitic stainless steel was used Table

1 shows the chemical makeup of the substance supplied by the manufacturer. An external diameter of 20 mm, an internal diameter of 12 mm, and an overall height of 12 mm were machined into specimens. Finish turning was used to create the outside surface.

3.3 LaserSurfaceAlloyingof316LSteel

LSA operations were carried out utilizing the re-melting strategy. It went through two stages. As the first phase in the procedure, the alloying substance was applied to the alloyed material (substrate). In order to get a laser-alloyed layer, the alloyed material and its covering were re-melted [32]. Like we said earlier, we used powders to dilute polyvinyl alcohol solution. The generated paste was applied to the exterior cylindrical surfaces of the 316L steel sample. An alloying substance was present in all of the 200-nm-thick layers of coating. The Positector 6000 gauge employed eddy current and magnetic induction to measure the thickness of the coating (DeFelsko, Poznan, Poland). As an alloying agent, the following powders were employed:

Boreal amorphousness

- MixtureofAmorphousBoronAndStellite-6PowdersWith Mass Ratio 1:1,
- MixtureOfAmorphousBoronAndNickel PowdersWith Mass Ratio 1:1,
- MixtureOfAmorphousBoronAndNi–CrPowdersWith Mass Ratio 1:1.

3.4 MicrostructureObservations

3.5 The ring-shaped specimens were cut perpendicular to the treated surface, across the laser tracks, following the LSA techniques outlined above. The microstructure of the laser-alloyed samples was studied in the plane perpendicular to the scanning direction by preparing cross sections. In order to create the metallographic specimens, the cut pieces were first put in a conductive resin. Using abrasive paper with varied granularities, they were then polished. During polishing, the Al2O3 slurry was finally applied. The laser-alloyed specimens were etched with a specific reagent to disclose their microstructure, which was made from a 25-gram combination of FeCl3, 25-mL HCl, and H2O. (100 mL). Using an optical microscope (OM) Metaval (Carl Zeiss, Poznan, Poland) and a scanning electron microscope (SEM) Vega 5135, the microstructures were studied (TESCAN, Poznan, Poland).

3.6 **X-rayMicroanalysisandPhaseAnalysis**

Measurements of the concentrations of specified elements in the laser-alloyed layer were made with a 55 utilizing the PGT Avalon X-ray microanalyzer (Princeton Gamma Technology, Poznan, Poland).take-offangle.Thecontentsofiron,chromium,nickel, molybdenum, cobalt, and boron weremeasured. Such elements corresponded to themost important elements of 316L steel (Fe, Cr,Ni,Mo),aswellastotheelements,whichweret he main components of alloying materials (B,Ni,Cr,Co).Theacceleratingvoltagewasequalt oonly12kV.Itenabledmoreaccuratemeasurem entsofsuchalightelementasboron.Si (Li) detector with an ultra-thin window wasapplied. The standardless quantitative analysisSEM bulk analysis was performed using ZAF (atomic number-absorption-fluorescence) matrix correction techniques. Boron measurements, however, necessitated a unique approach. This procedure's goal was to remove any carbon-based pollution. As a result, genuine standards of boron content were used to calibrate the apparatus. The standards were FeB and Fe2B phases made on borided Armco iron. There was no carbon dissolution in the iron. borides.

3.7 **Cohesion**

The standard test for determining the adherence of coatings was performed to examine the cohesiveness of laser-alloyed layers. The Rockwell C indentation test was used to determine the surface layer's cohesiveness. Cone-shaped diamonds were used to conduct the experiment.

as in the case of a typical hardness test using this method. The thickness of the sample has to be at least ten times greater than the depth of the indent that was discovered. It's common to see surface fissures and plastic deformation in the substrate after doing the test. An optical microscope (OM) Metaval was used to observe the indents and determine

the level of layer cohesiveness (Carl Zeiss, Poznan, Poland). An eye was trained on any microcracks and probable flaking or delamination that might have occurred as a result of the indentation.CorrosionTests

3.8AnodicAndCathodicPolarizationTests

In a neutral 3.5 percent NaCl solution, anodic and cathodic polarization experiments were performed on 316L stainless steel substrates with and without silane treatments. To ensure a stable potential, the silane-treated samples were maintained in the working solution for at least three hours prior to taking measurements. A platinum mesh and an Ag/AgCl electrode were employed as the counter electrodes. All of the measurements were made at a rate of one millivolt per second between Ag/AgCl and Ag/AgCl.

3.9 SaltSprayTesting

Using a 5 percent sodium chloride solution, the coatings were put through a neutral salt spray test under ASTM B117 to determine their corrosion resistance. Adhesive tape was applied to the specimens' backs and edges prior to exposure. To test the delamination behavior, a fake scratch was produced in the covering and pierced to the alloy substrate. The specimens were taken out of the salt spray chamber on a weekly basis and photographed using a digital camera to capture representative regions. Corrosion performance was evaluated by calculating the time of exposure to the initial incidence of corrosion, measuring corrosion creep from an artificial scratch, and evaluating the coverage with corrosion products from the scratch.

4.3.ELECTROCHEMICALIMPEDANCESPECTROSCOPYMEASUREMENTS

Electrochemicalimpedancespectroscopymeasurements (EIS) were employed to monitorthe corrosion performance of the silane treated316L stainless steel substrates in a 3.5 % NaClsolution. EIS measurements were carried out attheopencircuitpotential,usinganAutolabPGStat20instrument.Thedatawereobtainedasafunctionoffrequency,usingasinewaveof10mV amplitude peak to peak. A frequency rangeof 105 Hz to 10-2 Hz was selected. A three-electrodeelectrochemicalcellarrangementwas used, consisting of the working electrode (4.98cm2 of exposed area), Ag/AgCl electrode asreferenceandplatinum ascounterelectrode.

5. Applicationsof316/316lStainless Steel

- Oil& petroleumrefiningequipment
- Foodprocessingequipment
- Pulpandpaperprocessingequipment
- Soapandphotographic handlingequipment
- TextileIndustryEquipment
- Architectural
- Pharmaceuticalprocessingequipment

6. **Conclusions**

A review of the role of 316L stainless steel micro-abrasion-corrosion mechanisms in artificial saliva is presented in this research.Theresultsfromthemicro-abrasion-corrosiontestswereusedtogeneratepolarization

•curves, wastage and mechanism maps and todescribethematerial'stribo-corrosionbehaviour in a simulated oral environment.Itwas found that the corrosion resistant nature of316Lstainless steel madeitswear

•mechanism micro-abrasion dominated for alltestconditions.Thesuperiorcorrosionresistanceof316Lstainlesssteelhasresultedinamicro-abrasion

•rate to be significantly higher than corrosionrate. This was confirmed by the microscopyinspectionasanyvisualsignsofsurfacecorrosionhadbeenremovedbythemicroabrasion mechanisms whichpredominate.The polarisationcurve resultsdisplayedasignificantincreaseincorrosioncurrent

•density in the presence of abrasive particlessuggestingtheremovaloftheprotective chromiumoxidepassivefilm.Themicro-abrasionandcorrosionweightlossresultssuggestthat therate of corrosion

• inanodicconditionsincreaseswiththeincreaseofmicro-abrasion.Repassivationphenomena were observed in the polarisationcurveswithhighermicroabrasion.A higherfrequency of repassivation was observed forhigherrates of microabrasion.

References

[1] JimmyMehta,VarinderKumarMittalandPallav Gupta Role of Thermal Spray Coatings onWear, Erosion and Corrosion Behavior: A ReviewJournal of Applied Science and Engineering, Vol.20, No. 4, pp. 445452 (2017)

[2]Yan,F.K.;Liu,G.Z.;Tao,N.R.;Lu,K.Strengthand ductilityof316Lausteniticstainlesssteelstrengthenedbynano-scaletwinbundles.ActaMater.2012, 60, 1059–1071.

[3]A. Hayes, S. Sharifi and M.M. Stack Micro-abrasion-corrosion maps of 316L stainless steel inartificialsaliva*Correspondingauthor.E-mailaddress:Margaret.stack@strath.ac.uk

[4]C. Hodge and M. M. Stack, "Tribo-corrosionmechanismsofstainlesssteelinsoftdrinks,"Wear,vol. 270, no. 1, pp. 104–114, 2010.

[5]I. Hutchings, Tribology, Friction and Wear ofEngineering Materials. Elsevier Limited, 1992, p.284.

[6]M. . Stack and M. Mathew, "Micro-abrasiontransitions of metallic materials," Wear, vol. 255,no. 1–6, pp. 14–22, Aug. 2003.

[7]YongxinWanga,n,LipingWangb,JinlongLia , Jianmin Chen a,b , Qunji Xue a,b Tribologicalpropertiesofgraphite-likecarboncoatingscoupling with different metals in ambient air andwater Y. Wang et al. / Tribology International 60(2013)147–155

[8]FieldSK,JarrattM,TeerDG.Tribologicalpropertiesofgraphite-likeanddiamond-likecarboncoatings. TribolInt 2004;37:949–56.

[9]WenboQin1,JiajieKang1,*,JianshengLi2,* ,WenYue1,YaoyaoLiu3,DingshunShe1,QingzhongMao2andYushengLi2,*Tribological Behavior of the 316L Stainless Steelwith Heterogeneous Lamella Structure Materials2018,11, 1839; doi:10.3390/ma11101839

[10]MohsinTalibMohammeda*,ZahidA.Khanb, Arshad Noor Siddiqueeb Surface Modifications ofTitaniumMaterials fordeveloping Corrosion Behavior in Human Body Environment:AReviewMohsinTalibMohammedetal./ProcediaMaterialsScience6(2014)1610–1618

[11]MichałKulka1,*,DariaMikołajczak2,Natalia Makuch 1, Piotr Dziarski 1 Laser SurfaceAlloying of Austenitic 316L Steel with Boron andSome Metallic Elements: Microstructure Materials2020,13, 4852; doi:10.3390/ma13214852

[12]B.T. Prayoga a, S. Suyitno a, R. Dharmastitia The Wear behavior of UHMWPE against SurfaceModified CP-Titanium by Thermal Oxidation B.T.Prayogaetal.,TribologyinIndustryVol.38,No.4(2016)543-551

[13] NahidSultanAl-Mamuna,KashifMairajDeenb,WaseemHaidera Corrosionbehaviorandbiocompatibility of additively manufactured 316Lstainlesssteelinaphysiologicalenvironment:theeffectofcitrateionsAdditive Manufacturing34(2020)101237

[14] W.S.W.Harun,M.S.I.N.Kamariah,N.Muhamad,S.A.C. Ghani, F. Ahmad, Z.Mohamed,Areviewofpowderadditivemanufacturingprocessesformetallic biomaterials,PowderTechnology.327(2018) 128–151, https://doi.org/10.1016/j.powtec.2017.12.058.

[15] P.A.Dearnley,K.L.DahmandH.Çimenogˇlu, "The corrosion – wear behaviour ofthermallyoxidisedCP-TiandTi–6Al–4V",Wear,vol. 256, pp. 469–479, 2004.

[16] Glaeser,W.A.Steels.InMaterialsforTribology,1sted.;TribologySeries;Elsevier:NewYork,NY, USA, 1992;Volume20, pp. 1–260.

[17] Godec,M.;Donik,Cˇ.;Kocijan,A.;Podgornik,B.;SkobirBalanticˇ,D.A.E_ectofpost-treated low-temperature plasma nitriding onthewearandcorrosionresistanceof316Lstainlesssteelmanufacturedbylaser powderbedfusion.Addit.Manuf.2020, 32, 101000.

[18] Arslan E, Totik Y, Demirci E, Alsaran A,2010.InfluenceofSurfaceRoughnessonCorrosionandTribologicalBehaviorofCP-TiafterThermalOxidationTreatment.Journalof MaterialsEngineeringand Performance19:428–433.

[19] Yan, F.K.; Liu, G.Z.; Tao, N.R.; Lu, K.Strengthandductilityof316Lausteniticstainlesssteel strengthened by nano-scale twin bundles.ActaMater.2012, 60, 1059–1071.

[20] Fellah, M.; Labaïz, M.; Assala, O.; Iost, A.;Dekhil,L.TribologicalbehaviourofAISI316lstainless steel for biomedical applications. Tribol.Mater.Surf.Interfaces 2004, 7,135–149.

[21] Roohangiz Zandi Zand1 , Kim Verbeken2 ,Annemie Adriaens1,* The corrosion resistance of316L stainless steel coated with a silane hybridnanocompositecoating