9th WBC

9th World Biomaterials Congress

第九次世界生物材料大会

Innovative Biomaterials and Crossing Frontiers in Biomaterials and Regenerative Medicine

Final Program

June 1-5, 2012, Chengdu, China
www.wbc2012.com

BIOMATERIA

CSBM 中国生物材料学会 CHINESE SOCIETY FOR BIOMATERIALS

P-SAT-C-206	**Nanostructured Selenium for Introducing Anti-bacterial Properties to Materials (ID: 2019)** Qi Wang (Brown University, USA), Thomas Webster
P-SAT-C-207	**Growth and Viability of Staphylococcus Epidermidis on Uv Irradiated and Fatty Acid-coated Smooth Titanium Surfaces (ID: 1986)** Christiane Petzold (University of Oslo, NORWAY), Ståle Petter Lyngstadaas, Marta Monjo
P-SAT-C-208	**Polyacrylonitrile Nanofibrous Membranes with Superior Antibacterial and Easy-cleaning Properties through Hydrophilic Flexible Spacers (ID: 1764)** Xinsong Li (Southeast University, CHINA)
P-SAT-C-209	**The Significance of Superparamagnetic-iron-oxide Nanoparticles for Prevention of Implant Infections (ID: 587)** Guruprakash Subbiahdoss (University Medical Centre Groningen, NETHERLANDS), Shahriar Sharifi, Dirk W Grijpma, Sophie Laurent, Henny van der Mei, Morteza Mahmoudi, Henk J Busscher
P-SAT-C-210	**Bioactive and Antimicrobial Graded Ceramic Implants with Enhanced Strength (ID: 507)** Yu Zhang (New York University College of Dentistry, USA), Racquel Z LeGeros
P-SAT-C-211	**Effect of ZnCl2 on Plaque Growth and Biofilm Vitality (ID: 985)** Haijing Gu (Sun Yan-Sen University, CHINA), Junqi Ling, Danni Fan
P-SAT-C-212	**Degradation of Antibiotic Loaded PMMA Bone Cement in Crevice Corrosion Enviroments (ID: 3507)** Michael George Bryant (Univerisity of Leeds, UK), Xinming Hu, Richard Farrar, Robert Freeman, Ken Brummitt, Anne Neville
P-SAT-C-213	**Facile Synthesis of Silver-modified Carbon Nanospheres and Enhanced Antibacterial Properties (ID: 1641)** Jianghu Cui (Jinan University, CHINA), Chaofan Hu, Yunhua Yang, Jianhua Rong, Yingliang Liu
P-SAT-C-214	**Titania Nanotube Coated with Silver by Plasma Ion Implantation and Deposition (ID: 1115)** Shenglin Mei (The Fourth Military Medical University, CHINA), Yumei Zhang, Paul K Chu
P-SAT-C-215	**Antibacterial Properties of Novel 1D ZnO Nanowires on Medical Grade 316L Stainless Steel Surface (ID: 392)** Tak Lung Li (The University of Hong Kong, HONG KONG)
P-SAT-C-216	**Effect of Sn Addition on the Magnetic Susceptibility of Zr-Nb Alloy Preventing Artifacts in MRI (ID: 2096)** Naoyuki Nomura (Tokyo Medical and Dental University, JAPAN), Shun Nakagawa, Suyatatu , Ryota Kondo, Hisashi Doi, Yusuke Tsutsumi, Kazuhiko Noda, Takao Hanawa
P-SAT-C-217	**Bridging Approach to Regulate Immune Responses with Multi-segmented Metallic Nanorods (ID: 1575)** Young Ju Son (Kangwon National University, KOREA), Choi Ji Suk, Hye Sung Kim, Sujin Yoon, Eunju Jo, Younghee Kim, Jihyun Kang, Hyuk Sang Yoo
P-SAT-C-218	**Time-Lapse Cell Behavior of MC3T3 Preosteoblasts on Ti-6Al-4V Undergoing Electrochemical Stress Using Actin-Labeled Fluorescent Microscopy (ID: 3467)** Shiril Sivan (Syracuse University, USA), Jeremy Gilbert
P-SAT-C-219	**Caveolin-1: a New Biomarker of Cellular Response to Degradable Metallic Materials (ID: 3442)** Agung - Purnama (Université Laval, CANADA), Diego Mantovani, Jacques Couet
P-SAT-C-220	**Surface Patterning of NanoSiHA: in vitro Response from Osteoblasts (ID: 3041)** Gillian Munir (University College London, UK), Jie Hunag, Mohan Edirisinghe, William Bonfield, Lucy Di Silvio
P-SAT-C-221	**A Novel in vitro Calcium Phosphate Coating Technique on Magnesium Substrates (ID: 1495)** Shaylin Shadanbaz (University of Otago, NEW ZEALAND)
P-SAT-C-222	**Apatite-forming Ability of Ti-based Alloys Subjected to Acid and Heat Treatments (ID: 1932)** Seiji Yamaguchi (Chubu University, JAPAN), Tomiharu Matsushita, Takashi Nakamura, Tadashi Kokubo
P-SAT-C-223	**Enhanced Thrombogenic Response on Oxygen Etched Ti6Al4V Surfaces (ID: 1914)** Barbara Smith (Colorado State Univesity, USA), Nicholas Riedel, John Williams, Ketul C Pop
P-SAT-C-224	**Braided Stent for Transcatheter Aortic Valve (ID: 949)** Coralie Marchand (Université De Haute Alsace/ Lpmt, FRANCE), Frederic Heim, Bernard Durand, Nabil Chakfe
P-SAT-C-225	**Implant Survival and Marginal Bone Changes at Turned and Oxidized Implant Surfaces in Periodontitis Susceptible Smokers and Non-smokers. A Retrospective Case-Control Study. (ID: 418)** Shariel Sayardoust (The Institute for Postgraduate Dental Education, SWEDEN), Kerstin Gröndahl, Eva

Antibacterial Properties of Novel 1D ZnO Nanowires on Medical Grade 316L Stainless Steel Surface

Li, TL [a], Kao, RYT [a], Cheung, KMC [a], Wu, SL [b], Chu, PK [b], Luk, KDK [a] and Yeung, KWK* [a]

[a] *The University of Hong Kong, Hong Kong, China. E-mail: wkkyeung@hku.hk*

[b] *The City University of Hong Kong, Hong Kong, China.*

Abstract

Medical grade 316L stainless steel which is a common component of biomedical devices has the highest infection rates among clinically applied metals (L.G.Harris et al, 2006). Systemic antibiotic therapy, wound debridement and revision surgery are the consequences of patients suffering from implant associated infections. Prevention of biofilm formation could be achieved by preventing bacterial adhesion. Different kinds of strategies are suggested such as applying different metal coatings (Ag, Cu), grafting of special antibacterial peptides and loading of antibiotics. But there are many side effects such as strong antibacterial and cytotoxicity effect, complex procedures involved in the synthesis of ideal peptides and possible development of antibiotic resistant bacteria. A novel 1D nanostructured ZnO nanowire coating which provides biocompatible special surface topography is suggested. In addition, ZnO is regarded as safe by US FDA (21CFR182.8991) and can be easily fabricated by the simple hydrothermal method.

Methods

Fabrication of 1D ZnO nanowire coating on medical grade stainless steel

The fabrication method was based on literature (Chi-Liang Kuo et al, 2005) and has been modified. The stainless steel substrates were first cleaned and then immersed into zinc acetate ethanol solution (5.0 mM) and heated to 350°C for 20 minutes to form ZnO seed layer. Afterwards, they were immersed into an aqueous solution (zinc nitrate hydrate 25.0 mM and hexamethylenetetramine 25.0 mM) for 5 hours at 90°C to form 1D ZnO nanowires.

Bacterial adhesion assay (Live dead staining)

The ZnO nanowires coated samples were sterilized by 70% ethanol for 30 minutes and rinsed by 0.85% NaCl solution. 20ul of Tryptic soy broth (TSB) culture containing 10^5 *Staphylococcus aureus* (*S. aureus*) bacterial cells was inoculated on the samples at 37°C for 30 minutes. The samples were rinsed by NaCl solution again and the 20ul of dye mixture was applied onto their surfaces at room temperature for 20 minutes in dark. They were then rinsed by NaCl solution again and then examined by fluorescent microscope under a 40X objective.

Results

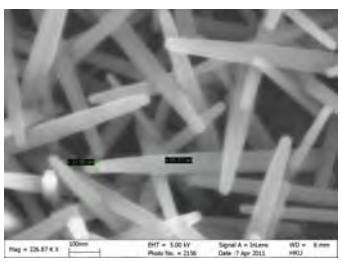


Fig.1 SEM image of the treated samples showing wires-like structure in nanoscale

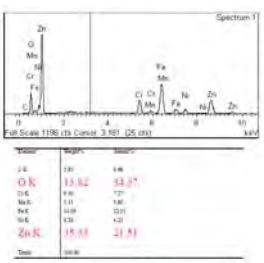
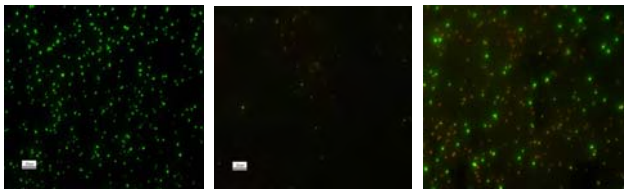
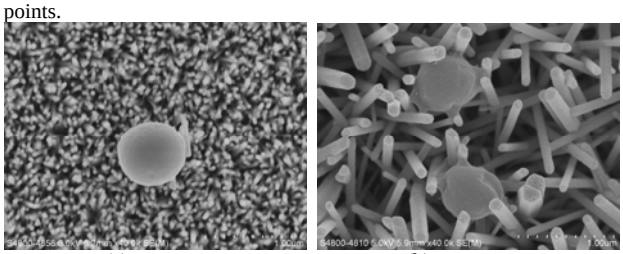


Fig.2 EDX scan of fig.1 showing high intensity of Zn and O atoms which indicated existence of ZnO nanowires



3(a) 3(b) 3(c)

Fig.3 Fluorescent microscope images (live dead staining) showing the number of live bacteria which was represented by the number of green dots on the samples surface. 3(a) Bare stainless steel. ZnO nanowires coated stainless steel with 5 hours [3(b)] and 17 hours [3(c)] growth time points.



4 (a) 4(b)

Fig.4 SEM images of *S.aureus* on ZnO nanowires coated samples after live dead staining. ZnO nanowires coated stainless steel with 5 hours [4(a)] and 17 hours [4(b)] growth time points.

1D ZnO nanowires were successfully fabricated on the surface of medical grade stainless steel as shown in SEM images (fig.1) and EDX scan (fig. 2). Live dead staining was carried out and indicated there were approximately 50% and 90% of bacteria reduction shown on the samples with 17 hours and 5 hours growth time point, respectively, as compared to control as shown in fluorescent microscope images (fig.3). Thus, all of the treated samples showed antibacterial effect. SEM images of *S.aureus* on ZnO nanowires coated samples after live dead staining were taken for further investigation (fig.4).

Discussion

The SEM images showed that the bacterial cells could attach to the lateral side of ZnO nanowires which had around 130nm in diameters when their size was fit to the spaces between the randomly orientated ZnO nanowires as shown in the samples with 17 hours growth time point. However, this was not the case in the samples with 5 hours growth time point because the spaces between the ZnO nanowires which had only around 60 nm in diameters were too small to be attached by the bacteria cells. In addition, the ZnO nanowires were perpendicular oriented to the surface of substrate which were relatively "well aligned" as relative to the size of bacteria cells. On the contrary, the bacteria cells could only attach on the top of the ZnO nanowires which provide limited contact area for bacterial attachment. It was suspected that the orientations of ZnO nanowires might be an important factor to strengthen the antibacterial effect of the ZnO nanowire coating.

References

1 L.G. Harris et al, Staphylococci and implant surface: a review. Injury, Int. J.Care Injured 37, S3 (2006)

2 Chi-Liang Kuo et al, Hydrothermal Synthesis of ZnO Microspheres and Heaxgonal Microrods with Sheetlike and Platelike Nanostructures. J.Phys. Chem. B 109, 20115 (2005)