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Hadi Firoozi, J Material Sci Eng 2018, Volume 7
DOI: 10.4172/2169-0022-C4-102

5th World Congress on
SMART AND EMERGING MATERIALS
April 19-20, 2018 Dubai, UAE

Study of surface characteristics of biomaterials used for medical devices and biosensors

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Introduction: The geometry, structural properties and importantly surface features of implants play an important role on their biocompatibility and post implantation induced foreign body response [1]. The formation of fibrotic tissue in the surrounding of implants can define their fate and potentially hinder the performance of medical devices by creating diffusional barriers for oxygen and nutrient transport [2-4]. The reduced transport dynamics can then lead to creation of hypoxic conditions affecting tissue function and performance of the implants [5,6]. It is therefore crucial to study the surface features and characteristics of biomaterials prior to implantation. In this study, porous pure titanium and stainless steel (304), two widely used prosthetics implants due to their proper elastic modulus, biocompatibility and corrosion resistant, and the ability to control their surface features are studied [7-11]. This investigation focuses on surface characteristics of these materials which are mostly used on outer surfaces of medical devices and as orthopedic implants.

Experimental procedure: Scanning electron microscopy (SEM) (performed by Quanta 600, FEI company) shows significant variability in the surface characteristic of all studied implant materials. The pore size and geometry is analyzed using MATLAB to map the pore distribution.

Results and discussion: The difference in pore size, pore shape and distribution of the studied stainless steel and pure titanium is shown in Figure 1. Their different porous structures can cause differences in induced foreign body response and ultimately the function of the medical devices and implants using them as outer surfaces. Our image analysis shows a lower variety in pore size distribution and shape in stainless steel as compared to titanium. This might be because of higher ability to control the surface features for this material. These surface characteristics are important for medical devices because the induced fibrosis can change the diffusional characteristics, moreover the are crucially important for orthopedic implants as well, since the quality of the bone formed is greatly influenced by the properties of the implants. This investigation can be further extended to in vivo studies and histological analysis, results can then show how changes in pore size distribution affects the foreign body response.

Conclusion: Our analysis matched with an extensive literature study on foreign body response of different materials and their surface characteristics confirms the importance of our investigation on selection of biomaterials with appropriate surface features based on their final use in medical devices or implant applications. The stainless steel has shown a higher uniformity in pore size distribution. Following studies will discuss the effects of pore distribution on mechanical and diffusional characteristics of these materials.

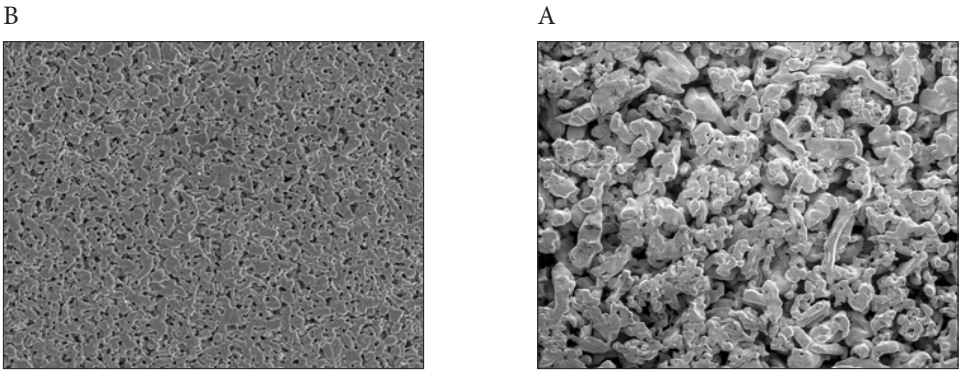

Fig. 1. Scanning electron microscopy (SEM) images of (A) porous stainless steel 314, (B) porous pure titanium.

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Biography

Hadi Firoozi is a last year M.Sc student in Materials Science at Science and Research Branch at Islamic Azad University. His research experiences include surface characterization and modification materials as well as different methods of surface coating including chemical vapor deposition (CVD) and physical vapor deposition (PVD).

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