142a Comparisons of Methods to Bond Metal and Chitosan: a Biopolymer for Use as an Implant Coating

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Implants are commonly made from commercially pure titanium and from different types of metal alloys, which include titanium combined with aluminum and vanadium and cobalt-chromium. The bone cells that surround these implants often times begin to leech away the metal ions needed for cellular function. This leeching causes a loosening of the implant, which will eventually lead to surgery, in order to replace the damaged implant. Also, bare metal does not allow for the proper attachment of bone cells in order to stabilize the implant. Osseointegration is a necessary occurrence in order to properly stabilize and incorporate the implant within the body.

One method to prevent biocorrosion, along with increasing osseointegration, is to bond a biocompatible coating onto the surface of the implant materials. Currently, several different methods are being used, which include calcium phosphate [1] and chitosan, a de-acetylated form of chitin. Chitin is the second most abundant form of polymerized carbon found in nature [2] and is primarily found in the exoskeletons of arthropods [3] and cell walls of fungi [4]. Chitosan, a biologically produced polymer, is a catonic copolymer of glucosamine and N-acetylglucosamine [5] and considered biocompatible because it can be degraded by specific enzymes [5]. Because of its biocompatibility, chitosan has been tested as wound dressings, bone implants, and drug delivery systems [5]. It may also work well as a coating on metal implants, improving osseointegration of implants for craniofacial and orthopaedic applications [3].

At Mississippi State University, we are investigating three methods to bound chitosan to three different metals. The chemical properties of the bonding methods will be examined using x-ray photoelectron spectroscopy (XPS) and Fourier Transform infrared spectroscopy (FTIR), while the crystalline structure will be determined using (XRD). The differences in bond strength and film hardness will be examined using an nanoindentor. Scanning Electron Microscopy (SEM) will then be used to determine where the film failed due to the nanoindention and the scratch tests.

[1] Y. Yang, C.M. Agrawal, K.H. Kim, H. Martin, K. Schulz, J.D. Bumgardner, J.L. Ong. *Journal of Oral Implantology*, 29, 6, 270-277, 2003

[2] G. Haipeng, Z. Yinghui, L. Jianchun, G. Yandao, Z. Nanming, Z. Xiufang. *Journal of Biomedical Materials Research*, 52, 285-295, 2000

[3] J.D. Bumgardner, R. Wiser, P.D. Gerard, P. Bergin, B. Chestnutt, M. Marini, V. Ramsey, S.H. Elder, J.A. Gilbert. *Journal of Biomaterials Science: Polymer Edition*, 14, 5, 423-438, 2003.

[4] T. Mori, Y. Irie, S.I. Nishimura, S. Tokura, M. Matsuura, M. Okumura, T. Kadosawa, T. Fujinaga. *Journal of Biomedical Materials Research (Applied Biomaterials)*, 43, 469-472, 1998.

[5] C. Jarry, C. Chaput, A. Chenite, M.A. Renaud, M. Buschmann, J.C. Leroux. *Journal of Biomedical Materials Research (Applied Biomaterials)*, 58, 127-135, 2001.