Enhancing Metallic Implants for Nitric Oxide Generation

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The most commonly used systemic drug delivery systems in medicine include oral ingestion, intravenous injection, and transdermal application. Despite their popularity, they are limited by issues such as first pass metabolism, patient compliance, undesirable side effects on target tissue, and/or low dosage at target site.[1] Alternative strategies have been developed to overcome these issues, one of which includes implantable drug delivery systems.[2] Currently, metallic-based implants are the most widely used and are considered a reliable choice in the healthcare field, however, they tend to suffer from bacterial contamination on their surface.[3] Consequently, the ability for localized antibacterial drug delivery has become essential.[4] Nitric oxide (NO) is a well-known antibacterial agent that can be used for this application.[5] We have developed a heat treatment method that imparts metallic implants with the ability to perform catalytic generation of NO (Figure 1), with 30 µM being generated within 24 hours in a linear and sustained manner for stellite alloys. The NO generation was tuned by varying the implant dimension, NO prodrug concentration (0 - 200 µM), and heat treatment conditions (0 - 2 hours, 300 - 900 °C). The heat treatment effect on the metallic implants were characterized via X-ray Photoelectron Spectroscopy, Energy-Dispersive X-ray Spectroscopy, Raman Spectroscopy, Scanning Electron Microscopy, and Atomic Force Microscopy. Among the different types of metallic implants investigated, stellite alloys maintained their catalytic activity for 5 cycles with no decrease in performance, allowing for long-term sustained NO delivery. Furthermore, antibacterial properties (up to 40% for the conditions tested) were demonstrated with no decrease in cell viability. This study demonstrates a rapid (1 hour) and simple method to provide antibacterial properties to metallic-based implants.

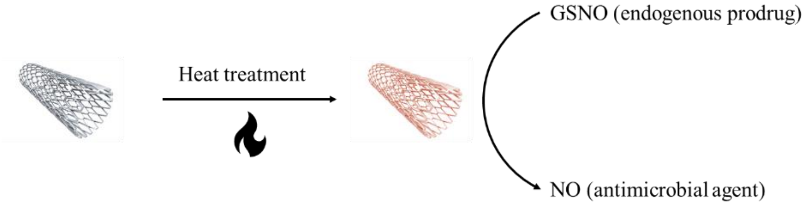

Figure 1: Schematic diagram of metallic implants demonstrating catalytic properties upon heat treatment towards endogenous prodrug degradation for nitric oxide generation.

References:

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