

National Aeronautics and Space Agency: Surgical Implant Technology Research

Orthopedic implant decontamination is an application developed from NASA research on combating the corrosive effects of atomic oxygen in space. Understanding this corrosive gas has resulted in new methods to decontaminate surgical implants.

Lead Agency:

National Aeronautics and Space Agency (NASA)

Agency Mission:

NASA's mission is to pioneer the future in space exploration, scientific discovery and aeronautics research.

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General Description:

Orthopedic implant decontamination is a spinoff application that has been developed as a direct result of NASA's research on low Earth orbital atomic oxygen interactions with spacecraft materials. The contribution consists of a process for removal of biologically active contaminants from the surfaces of orthopedic implants. Currently most orthopedic implants have endotoxins on their surfaces, which cause inflammation and pain. Such responses can lead to joint loosening and implant failure. Sterilization does not remove endotoxins because they are non-living chemicals consisting of mostly bacterial cell wall fragments. Implant surface exposure to atomic oxygen has been demonstrated to fully remove all endotoxins thus minimizing the chances of inflammation in the patient after surgery.

The technology that inspired the spinoff applications was NASA's investigation of low Earth orbital atomic interaction with materials. All hydrocarbon materials and hydrocarbon polymers have been found to erode through oxidation when exposed to the low Earth orbital environment. As a result of this reactive environment polymers used for solar array blankets and thermal control materials can be eroded away unless protective coatings could be used to prevent

chemical reactions from occurring. Protective coatings were developed to protect such polymers. Validation of protective coating solutions to atomic oxygen erosion needed to be performed in ground laboratory facilities. To address NASA's mission needs, ground based atomic oxygen facilities were developed and used to validate full mission durability for International Space Station (ISS) solar array blanket materials. Protective coatings developed for ISS solar array blankets are now used on all the USA supplied ISS solar arrays. The resulting knowledge of atomic oxygen interaction with materials and being made aware of specific biomedical needs provided the inspiration for the innovation of this biomedical application.

Excellence: What makes this project exceptional?

Exposure to atomic oxygen is the only known method that fully removes all endotoxins on surgical implants, thus minimizing the chances of inflammation in the patient after surgery.

Significance: How is this research relevant to older persons, populations, and/or an aging society?

Osteoarthritis affects between 20% and 30% of the people in the USA over 70 years old and 32 million people of all ages. There are 350,000 hip fractures in the USA each year that require orthopedic implants for repair. It is estimated that by the year 2050 there will be 1800 hip fractures per day that will require surgery. Almost all such surgeries will require implantation of orthopedic devices that are currently contaminated with biologically active chemicals which can cause inflammation. The quality of life and financial cost associated with inflammation resulting from implant contamination is enormous. As the average life expectancy increases along with weight of Americans the incidence of restorative orthopedic surgery will obviously increase. Surveys indicate that the worldwide orthopedic implant market was \$4.5 billion in 2002 and is expected to be \$7 billion in 2007. The quality of life improvements and reduction in corrective orthopedic operations enabled by reduction in inflammation through use of atomic oxygen removal of biologically active contaminants would be significant.

Effectiveness: What is the impact and/or application of this research to older persons?

The value of this technology will increase as the life expectancy increases and average weight of adults increases. Although this nomination deals with orthopedic implants many other surgical implant surfaces may cause adverse biological responses which lead to functional compromises due to presence of biologically active contaminants. One example is titanium vascular stents which may occlude if there is a presence of organic contaminants which are used in the machining process during fabrication.

Innovation: Why is this research exciting or newsworthy?

Recent tests of commercially produced, sterilized and packaged bone screws from four different orthopedic supplier companies indicated that three quarters of the screws showed presence of endotoxins on their surface.