Mimicking Nature to Produce Novel Surfaces for Orthopaedic Implants Gains Researcher National Attention

Dr. Fereydoon Namavar
Professor and Director
Nano-Biotechnology Laboratory

Dr. Fereydoon Namavar, and his team at the Nano-Biotechnology Laboratory in UNMC's Department of Orthopaedic Surgery, recently garnered national attention by being accepted for publication in the prestigious *Nano Letters* journal, a 'leading forum for nanoscale research' and #1 in impact factor out of 32 journals in Nanoscience and Nanotechnology according to the 2006 Thompson Scientific Journal Citation. The manuscript is currently available on the journal's web site and will be published in the April issue of *NanoLetters.*

The manuscript, "The Lotus Effect in Engineered Zirconia," demonstrates how the group mimicked the properties of the lotus leaf, a symbol of purity known for its hydrophobic properties and ability to stay clean, in order to create ultra-hydrophilic surfaces for use in orthopaedic implant devices. When a drop of water hits a lotus leaf the water rolls off the surface washing away dirt and dust, acting as a self-cleaning mechanism.

"Applying the same principal, we have engineered a nanocrystalline cubic Zirconia coating with super hydrophilic properties and total wettability to water," said Dr. Namavar. "These coatings have the potential to be used for many applications including orthopaedic artificial implants, tissue engineering, and cell adhesion and proliferation."

Dr. Namavar is a professor and director of the Nano-biotechnology Laboratory at the University of Nebraska Medical Center's Department of Orthopaedic Surgery & Rehabilitation. Through their research he, along with his staff and other faculty members, have used ion-bombardment to develop transparent nanocrystalline Zirconia films that possess the combined properties of hardness and complete wetting behavior, designed to benefit tribology, wear-reduction and biomedical applications requiring ultra-hydrophilic surfaces.

In orthopaedic terms this translates into prolonged life of orthopaedic implants and fewer revision surgeries, due to reduced friction and wear of the implant, as well as enhanced bone growth. Failure of biointegration is one of the primary concerns with orthopaedic devices because it prevents long-term stability, which contributes to pain, implant loosening and infection that usually necessitates revision. Revision surgery is required when the device fails, but is generally less successful than the primary surgery and costly in terms of patient hardship and expense. Extending the life of artificial implants would eliminate patient suffering and save substantial healthcare dollars.

The ion beam assisted deposition (IBAD) process is the key. IBAD combines evaporation with concurrent ion beam bombardment in a high vacuum environment. Energetic ions then produce engineered nanocrystals that are "stitched" to a substrate, producing surface properties that are not possible through conventional techniques. This IBAD system is unique in its characteristics such as power, size, vacuum ability, and potential.

"To our knowledge it is unparalleled in any academic institution in the United States and is comparable or better than most systems used by high technology companies," said Dr. Namavar.

Dr. Kevin Garvin, professor and chair of Orthopaedic Surgery, and Dr. Hani Haider, associate professor and director of the department's Biomechanics Laboratory, are co-authors on the manuscript. In addition, researchers from the Nebraska Centre for Materials and Nanoscience at the University of Nebraska-Lincoln, the Department of Chemistry at the University of Nebraska-Lincoln, and the Department of Physics at the University of Nebraska-Omaha, assisted with the manuscript. The project was funded by a grant from the Nebraska Research Initiative.

To peruse the manuscript and full list of authors, go to the Nano Letters website where the full manuscript is downloadable in a PDF format; or find it in the April issue of Nano Letters, Volume 8, Issue 4, pages 988-996.