

# NeoTREX™

A division of CSU Ventures, Inc.,  
an affiliate of Colorado State University.



## Multifunctional Nanostructured Interfaces for Improved Osseointegration and Drug Delivery

Placement of prosthetic skeletal implants has improved the quality of life for millions of people in the world. It is estimated that over 500,000 total joint replacements, primarily hips and knees, and between 100,000 and 300,000 dental implants are used each year in the United States alone. Orthopedics and dentistry are two areas that have significantly benefited from the development of advanced materials for implantable devices. Modifying the surface of an implant either by providing topographical cues, or with a bioactive coating, or a combination of both that encourages bone cell attachment and growth is one way to increase osseointegration and help stabilize the implant. However, there are several challenges associated with acquiring and retaining stable fixation of the device at the bony site. Further, there are several problems related to dissolution of the coatings over time, and cracking and separation from the metallic substrate. Thus, a critical goal of current orthopedic and dental biomaterials research is to design implants that induce controlled and guided growth around the implant, as well as rapid healing. In addition to the acceleration of normal wound healing, these implants should result in formation of a characteristic interfacial layer with adequate biomechanical properties. Dr. Popat is in collaboration with Dr. Grimes at Penn State to develop methods to create metal-oxide nanostructured interfaces for orthopedic and dental implants. These interfaces are robust with micro and nanoscale architectures that can also be conjugated with osteoconductive or osteoinductive biomolecules, to enhance the apposition of bone from existing bone surfaces and stimulate new bone formation. Dr. Popat is using simple anodization techniques to create arrays of nanotubes on implant surface. Preliminary results have shown that such nanotubes arrays enhance mesenchymal stem cell adhesion and differentiation, thus resulting in increased bone deposition.

The nanotube arrays can also be used for localized drug delivery therapies. The proposed nanotube-based localized drug delivery system offers several advantages over some of the current delivery techniques. The tube diameter, wall thickness and length can be easily modified to satisfy the specific requirements of the drug to be delivered (i.e. the size of the drug molecule and release rates). Drs. Popat and Grimes have shown that the length of the nanotube array can be varied anywhere from 200 nm to 1 mm, the thickness of the nanotube walls from 5nm to 34nm, and the nanotube pore diameter from 12nm to 180nm. Further, these interfaces exhibit very hydrophilic behavior (contact angles  $\approx 0^\circ$ ), which can be easily adjusted by modification with organic molecules. However, their wettability has been shown to persist during prolonged storage at room temperature. Thus, the remarkably large surface area of the nanotube-array structure and the ability to precisely tune pore size, wall-thickness, and nanotube length to optimize biotemplating properties along with their surface characteristics are among the many desirable properties to use these types of surfaces as drug eluting coatings for implantable devices.

**ID: CSURF 09-039**

### Inventor Information

Dr. Ketul C. Popat

Dr. Craig A. Grimes

### Contact Information:

Steve Foster

Phone: 970.297.1276

Email: [steve@neotrex.org](mailto:steve@neotrex.org)

[www.neotrex.org](http://www.neotrex.org)

Colorado  
State  
University