NANOVIS®

# Raising the Standard for Implant Performance

IMPACT SERIES

Implants fail for three primary reasons: poor osseointegration, bacterial infection, and inadequate biological response at the interface. These challenges continue to drive revision surgeries, increase cost of care, and slow recovery for patients. If surface architecture could be engineered to accelerate bone attachment while reducing bacterial adhesion and improving healing response, without changing implant design or manufacturing, implant performance expectations would fundamentally shift. This technical question sits at the foundation of Nanovis' work.

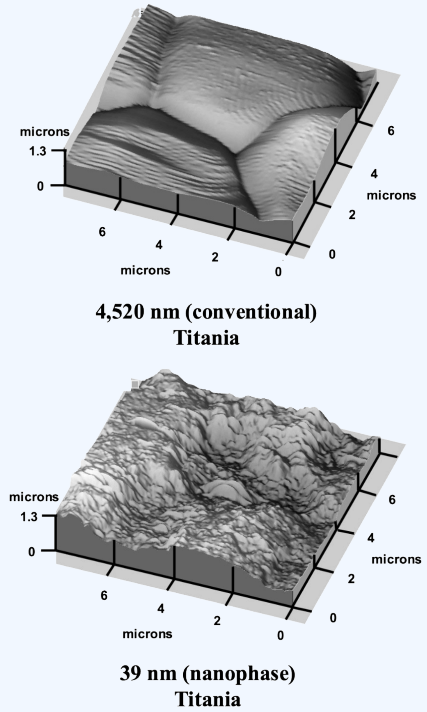


Figure 1

*The first published study demonstrating increased osteoblast (bone forming cell) function on nanomaterials compared to current implants at that time [1]. This led to the first issued patent using nanomaterials to promote bone growth which was eventually licensed to and formed Nanovis in 2006 [2]. The numbers in the figure refer to the average surface feature size.*

## A Scientific Journey Rooted in Mechanism, Not Assumption

At six years old, Dr. Thomas Webster fractured his femur after being struck by a car. The experience sparked early curiosity about bone healing and failure. Years later, as a Ph.D. researcher focused on nanotechnology in orthopedics, this curiosity became a career-defining pursuit. What if implants could mimic bone at the nanoscale?

In the 1990s, Dr. Webster's graduate group published early research demonstrating that nanoscale surfaces could improve osteoblast behavior by mimicking natural bone nanotopography (Figure 1) [1]. Bone is inherently nanostructured, composed of calcium phosphate crystals more than 10,000 times smaller than human hair. This led to a central hypothesis:

**If bone is nanostructured, implants should be too.**

This work contributed to early patents for using nanomaterials to enhance bone growth [2] and helped establish nanoscale surface engineering as a new scientific pathway for improving implant performance.

## From Research to Repeatable Outcomes

From 2000 to 2005, while serving as a faculty member at Purdue University, Dr. Webster's research expanded beyond bone and demonstrated enhanced cellular responses across cartilage, vascular tissue, bladder tissue, and neural tissue [3 to 6]. Subsequent studies showed reductions in bacterial adhesion (Figure 2) [7], favorable modulation of inflammatory signaling [8], and improved healing kinetics relative to micro-only surfaces.

Collectively, this body of work, led and advanced by pioneers in the nanotechnology field including Dr. Webster, resulted in multiple patents that were later licensed to Nanovis for commercial development [10 to 14]. The research established nanoscale surface engineering as a scientifically grounded approach to influencing biological response at the implant interface.

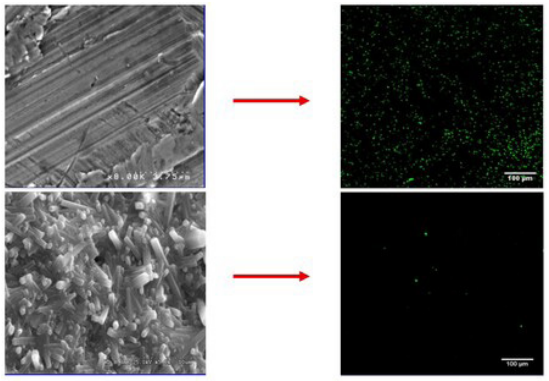

Figure 2

*Nanotextured titanium reducing MRSA colonization (stained green) after 24 hours of culture. Top: Conventional non-nano and Bottom: Nanotexture.*

## From Scientific Leadership to Platform Translation

By the early 2000s, the scientific evidence was clear. Nanoscale surface architecture consistently influenced biological response across multiple tissue types. The remaining challenge was not discovery, but translation.

Academic research alone could not address the regulatory, manufacturing, and scalability requirements necessary to bring nanoscale surface technologies into routine clinical use. To bridge this gap, an organization designed for regulated medical device development was required.

In 2006, Nanovis was formed to translate foundational nanoscale surface research, including work led by leaders such as Dr. Webster, into validated, manufacturable technologies for commercial implant systems. The company was established with a focus on preserving scientific integrity while enabling consistency, scalability, and OEM integration.

## Engineering Nanoscale Science into a Validated Surface Platform

nanoVIS Ti™ represents the translation of decades of nanoscale surface research into our first validated surface platform designed for clinical and commercial use. Rather than altering implant geometry or material composition, nanoVIS Ti™ applies a controlled titanium dioxide nanotube architecture to titanium surfaces, preserving implant design intent while influencing biological response at the interface.

This platform approach allows OEM partners to leverage the biological mechanisms demonstrated through foundational nanotechnology research while meeting the reproducibility, quality, and process control requirements expected in regulated medical device manufacturing.

Regulatory recognition followed with the **FDA Nanotechnology Designation (510(k) K191822)**, confirming that nanoVIS Ti™ represents a true nanoscale surface with biological relevance rather than a micro-rough claim. This designation validated not only the surface architecture, but also the consistency and control required for commercialization.

## Delivering Nanoscale Technology at Scale

With the surface platform established, Nanovis focused on ensuring nanoscale technology could be delivered consistently, efficiently, and at commercial scale.

Nanovis built its operating model around three core principles that support OEM adoption across development, validation, and production.

### Science-Expertise

A deep understanding of nanoscale mechanisms and their influence on biological response, grounded in decades of fundamental research.

### We Make It Easy

Integration models designed to fit within existing OEM supply chains, preserving manufacturing workflows while enabling scalable surface application.

### Proven Results with Experience

Clinical validation, mitigation of regulatory risk, and demonstrated industry adoption across thousands of implants.

These principles align with the Nano Surface Technologies Four Pillars of Healing, which connect nanoscale engineering to therapeutic benefit at the implant surface:

- **Reduces Bacterial Colonization**
- **Improved Inflammatory Response**
- **Increases Vascularization**
- **Accelerates Osseointegration**

## From Validation to Clinical Adoption

Nanovis research has been supported by the NSF, NIH, and leading research organizations. Industry adoption further confirms platform maturity. Integration of Nanovis nanotube technology into the Medtronic interbody portfolio demonstrates commercial readiness and trust.

Today, more than 25,000 implants are clinically in use with zero reported infections in the MAUDE database. OEM partnerships continue to expand across multiple markets:

- **Spine and orthopedic systems beyond interbody**
- **Dental implant systems**
- **Foot and ankle reconstruction**
- **Hip and knee arthroplasty**
- **Additional implant categories where osseointegration and infection prevention matter**

## Where the Industry Goes Next

Implant performance expectations continue to rise as devices become more complex, and clinical scrutiny increases. Advances in implant design, materials, and manufacturing have accelerated, yet long-term outcomes remain highly dependent on the biological response at the implant interface.

Nanoscale surface engineering has emerged as a critical lever for improving implant performance. With demonstrated effects on bacterial response, immune modulation, vascularization, and osseointegration, nanoscale architecture is no longer a theoretical advantage. It is a validated, manufacturable technology already in clinical use.

nanoVIS Ti™ represents a platform approach to surface engineering that integrates into existing OEM workflows without requiring design changes or manufacturing disruption. Backed by regulatory recognition, extensive scientific validation, and real-world clinical adoption across more than 25,000 implants, the technology offers a practical path to elevating implant performance at scale.

## Start the Conversation

If you are evaluating surface technologies to improve implant performance, reduce development risk, or accelerate time to market, Nanovis welcomes the opportunity to collaborate. Our team works alongside OEM engineering and R&D leaders to integrate validated nanoscale surface technologies into existing implant platforms.

The question is no longer whether nanotechnology will shape the future of implants.
**The question is: who will lead its adoption?**

Contact Nanovis to explore what nanotechnology surface engineering can deliver to your implant's surface.

REFERENCES

NANOVIS®

## Learn More About Us

www.nanovistechnology.com

## Connect With Us


(877) 907-NANO

info@nanovistechnology.com

5865 East State Road 14
Columbia City, IN 46725

LinkedIn.com