

## APPLICATION NOTE

# Bioactive ALD coatings for surgical metal implants



## INTRODUCTION

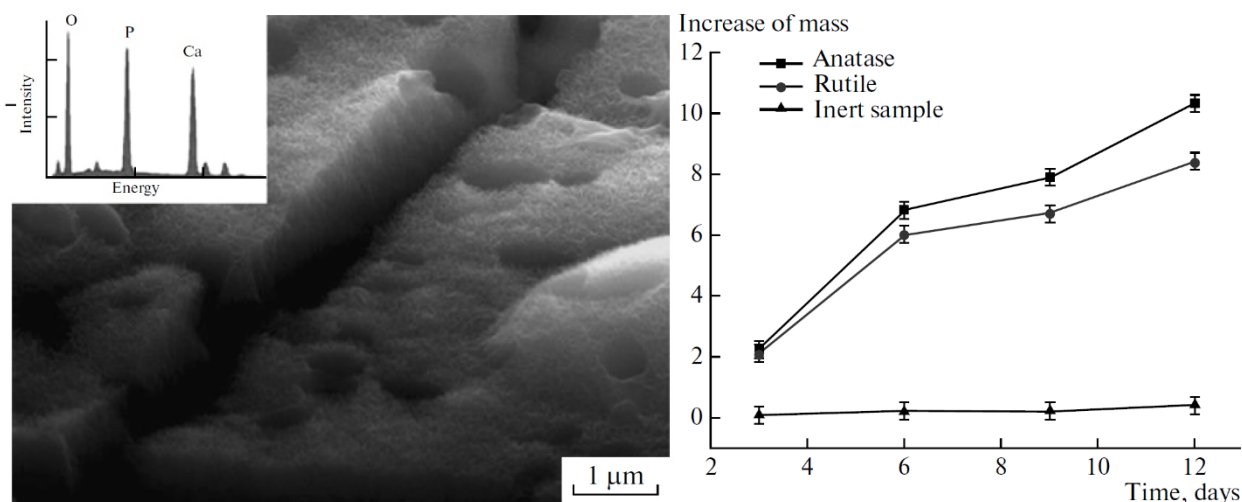
- Picosun's Atomic Layer Deposition (ALD) technology offers an ideal method to improve the lifetime, safety and comfort of use of dental and orthopaedic metal implants.
- Picosun's ultra-thin, biocompatible ALD coatings form hermetic encapsulation around the implant. This prevents corrosion caused by human body fluids, and prevents metal ion leakage from the implant.
- For dental implants, bioactive ALD coating enhances the osseointegration process and thus shortens the healing time.

## ADVANTAGES OF PICOSUN'S BIOCOMPATIBLE COATINGS FOR DENTAL AND ORTHOPAEDIC METAL IMPLANTS

- Medical implants and implantable devices need to be sealed against corrosion caused by body fluids, and the body needs to be protected from inflammatory and rejection reactions and possible metal ion leakage caused by the implant.
- Biocompatible, dense and pinhole-free ALD encapsulation provides reliable, hermetic sealing on dental/orthopaedic implants and other stainless steel or titanium items.
- In titanium-based dental implants the implant surface functionalization with bioactive ALD  $\text{TiO}_2$  coating accelerates the osseointegration process<sup>(\*)</sup>. ALD  $\text{TiO}_2$  has excellent adhesion also to the implant material, resulting in a tight bond between the implant and the bone.
- The excellent quality, uniformity and conformality of the ALD films ensures that the desired functionality can be achieved with much lower film thicknesses compared to conventional methods, leading to material and cost savings.
- Ultra-thin ALD films do not increase the mass or dimensions of the implant.
- ALD is a gentle, gas-phased coating method and process temperatures are moderate, which eliminates the risks for microscopic surface damage to the items during coating.
- Picosun provides a variety of biocompatible ALD materials:  $\text{TiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{HfO}_2$ ,  $\text{SiO}_2$ ,  $\text{ZrO}_2$ ,  $\text{Nb}_2\text{O}_5$ ,  $\text{Ta}_2\text{O}_5$ ,  $\text{AlN}$  and  $\text{TiN}$  (tested at FICAM – The Faculty of Medicine and Health Technology, University of Tampere, Finland with Cytotoxicity tests with cell culture medium according to the ISO 10993-5 standard, and 3 weeks soaking tests in PBS (phosphate-buffered saline) at 87 °C).
- High throughput, cost-efficient surface treatment of thousands of implants per run is realized in Picosun's large scale batch ALD reactors.

<sup>(\*)</sup>*B.S. Smbatyan et. al., Rossiyskaya Stomatologiya 4, p. 15-24, 2014.*





Left: SEM picture and EPMA analyses of Ti plates with anatase TiO<sub>2</sub> coating, after soaking in SBF for 6 days Right: Comparison of HA formation on plain and ALD TiO<sub>2</sub> coated Ti samples in SBF(\*\*).

(\*\*)A.A. Solovyev et. al., *Nanotechnologies in Russia* 8, Nos. 5-6, p. 388-391, 2013.

## CUSTOMER REFERENCE

CONMET LLC has used Picosun's ALD technology and equipment for several years to coat bioactive coatings on medical implants. Read CONMET's customer testimonial here: <https://www.picosun.com/press/picosun-customer-interview-conmet-llc/>

## ABOUT PICOSUN AND ALD

Picosun is the leading provider of AGILE ALD<sup>®</sup> thin film coating solutions for global industries and prominent research organizations. PICOSUN<sup>®</sup> ALD equipment are used in wafer-based semiconductor industries such as IC components, LEDs and sensor manufacturing, powder materials processing, and coating of macroscopic 3D items such as machinery parts, medical implants and devices, watch parts and coins.

Picosun's history reaches back over four decades, to the invention of the ALD technology itself. Our exclusive dedication to ALD and the unmatched, Ph.D level expertise of our team make us your ideal partner in all your thin film coating needs!

ALD is the most sophisticated thin film coating method of today, and a key enabling technology in modern microelectronics industries. Ultra-thin ALD films have the highest conformality and uniformity down to nanometer-scale surface details and, thanks to the surface-controlled, self-limiting film growth mechanism, they are dense, crack- and pinhole-free. Several ALD materials are also intrinsically biocompatible and thus optimal for medical applications.

## THE PRINCIPLE OF ALD



Introduction of molecules  
containing element A.



Adsorption of the molecules  
on the surface.



Introduction of molecules  
containing element B and  
reaction with element A on  
the surface.



Completion of one  
monolayer of compound AB.

Repeat cycle till desired film  
thickness is reached.

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Multiple patents granted and pending, including but not limited  
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