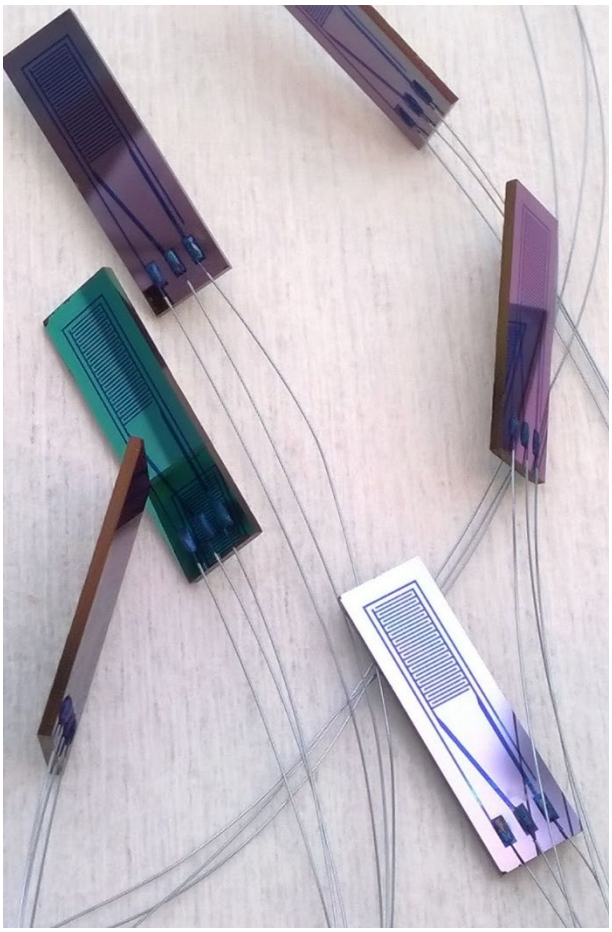
picosun AGILE ALD

APPLICATION NOTE

Biocompatible ALD coatings for medical microimplant encapsulation



INTRODUCTION

- **Picosun's Atomic Layer Deposition (ALD) technology offers an ideal method for protection of medical microimplants with electronics.**

- **Picosun's ultra-thin, biocompatible ALD coatings form hermetic encapsulation around the implant. This prevents corrosion of the implants' sensitive electronics, caused by human body fluids, and prevents metal ion leakage from the implant.**

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ADVANTAGES OF PICOSUN'S BIOCOMPATIBLE COATINGS FOR MEDICAL MICROIMPLANTS

- Remote sensing and therapeutics through self-powered, wirelessly operating microimplants is an emerging technology in e.g. neural stimulation and diagnostics, and in blood glucose, blood pressure, intraocular and intracranial pressure measurements.

- Hermetic encapsulation of the implants is required to protect them from the corrosive effect of body fluids, and to protect the body from the possible inflammatory or rejection reaction caused by the implant.

- Picosun has developed an ALD nanolaminate encapsulant that can potentially ensure microimplant lifetime of over 10 years in human body environment(*).

- The performance of the ALD nanolaminate encapsulants has been investigated in accelerated aging tests in 87 ºC saline, comparing encapsulated and bare microelectronic chiplets for wireless body implants (tests performed at Brown University, USA).

- The chiplets stayed operational with no signs of degradation in the hot saline bath for over 180 days. This implies an equivalent lifetime of over 10 years in human body environment at 37 °C(**).

- Ultra-thin ALD films do not increase the mass or dimensions of the implant.

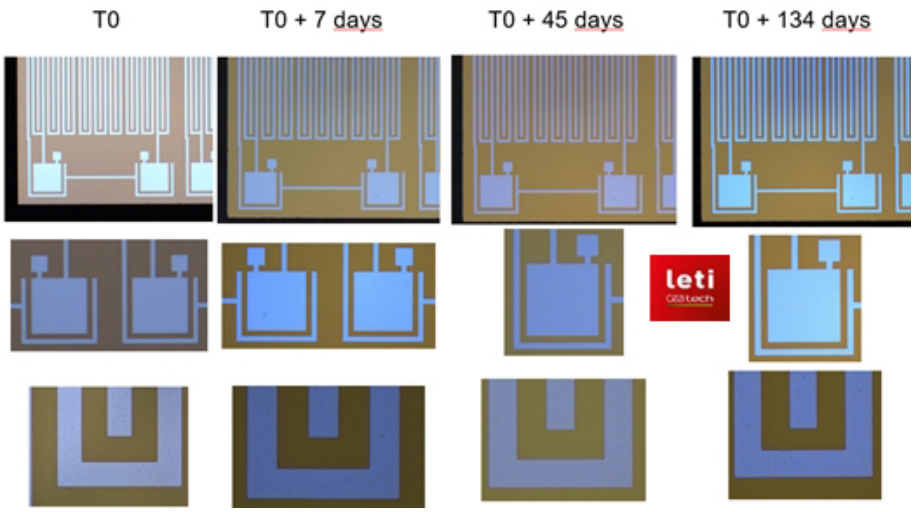
- ALD is a gentle, gas-phased coating method and process temperatures are moderate, which eliminates the risks for microscopic surface damage to the items during coating and makes the method suitable also for sensitive materials.

- Picosun provides a variety of biocompatible ALD materials: TiO_2, Al_2O_3, HfO_2, SiO_2, ZrO_2, Nb_2O_5, Ta_2O_5, AlN and 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 ºC).

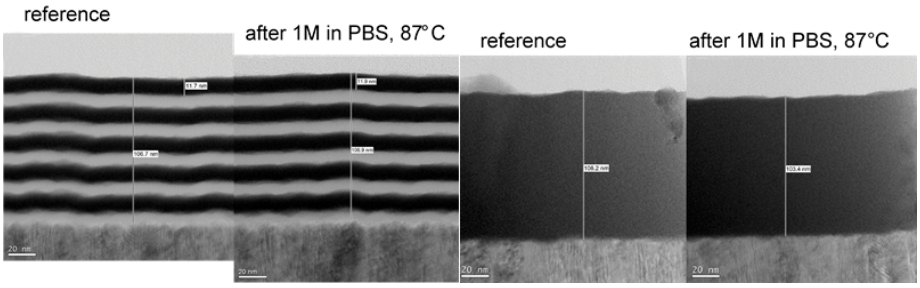
- High throughput, cost-efficient surface treatment of thousands of implants per run is realized in Picosun's large scale batch ALD reactors.

(*) J. Jeong et. al., Adv. Funct. Mater. 2018, 1806440.

(**) Standard accelerated lifetime extrapolations, based on the rates of chemical reactions doubling when the temperature is increase by ~10 degrees Celsius.



Microimplant electronics protected by Picosun's ALD HfO_2. No changes after soaking in 87 °C PBS for over 3 months, which correlates to over 10 years in human body (image source CEA-Leti, France, InForMed project).



TEM micrographs of Picosun's ALD nanolaminate and oxide encapsulants after one month soaking tests in 87 °C PBS. No corrosion observed (image source ULIMPIA-project).

ABOUT PICOSUN AND ALD

Picosun is the leading provider of AGILE ALD® thin film coating solutions for global industries and prominent research organizations. PICOSUN® 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.

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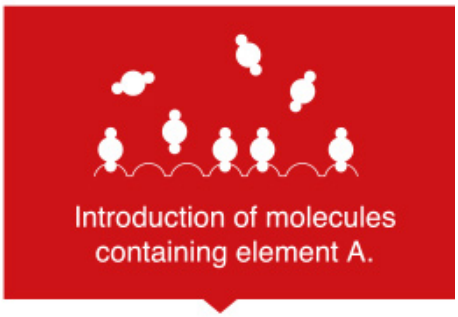
THE PRINCIPLE OF ALD



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