



SAPIENZA  
UNIVERSITÀ DI ROMA

Seminar, Prof. Dr. Ing. Giuseppe Pezzotti

## **"SILICON NITRIDE: A BIO-CERAMIC WITH A GIFT"**

December 12<sup>th</sup>, 2025

h. 11.00 a.m

Department of Basic and Applied Sciences for Engineering (SBAI)

"La Sapienza" University of Rome,

Via Scarpa 16, Roma

"Aula Seminari – RM004"

Silicon nitride ( $\text{Si}_3\text{N}_4$ ) has emerged as a uniquely "gifted" bioceramic whose surface chemistry, structural versatility, and bioactive behavior redefine what advanced ceramics can achieve in medicine. In this lecture, it will be explored how the intrinsic physicochemical features of silicon nitride, its controlled nitrogen release, in situ formation of biogenic silanols, and stable yet highly functionalizable oxynitride interface, can create a surface environment that is simultaneously osteogenic, antimicrobial, and anti-inflammatory. By combining Raman spectroscopy, X-ray photoelectron spectroscopy, and in vitro cell-material interaction studies, the lecture will clarify the molecular-scale processes underlying protein adsorption, bacterial membrane disruption, hydroxyapatite nucleation, and redox-modulating reactions unique to  $\text{Si}_3\text{N}_4$ . It will be further highlighted the distinct biomedical advantages of silicon nitride in both its bulk form, where mechanical strength, radiolucency, and long-term chemical stability support load-bearing spinal and orthopedic implants, and as a thin coating, where its tunable surface functionalities enhance the bioperformance of metals and polymers. Applications spanning orthopedics, dental medicine, soft-tissue engineering, neurosurgery, and antimicrobial coatings for high-risk clinical environments will be presented. Special attention will be given to recent developments in  $\text{Si}_3\text{N}_4$ -coated titanium and polymer implants, which combine structural resilience with superior osseointegration and infection resistance. By showcasing silicon nitride as a bioceramic that couples structural excellence with a biologically intelligent surface, this lecture will position  $\text{Si}_3\text{N}_4$  as a transformative material platform capable of shaping the next generation of regenerative and infection-resistant medical technologies.

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Sapienza University of Rome – Via Scarpa 16. - SBAI (RM004)



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DIPARTIMENTO DI CHIMICA E TECNOLOGIE DEL FARMACO

## Presentation of Prof. Dr. Ing. Giuseppe Pezzotti



Giuseppe Pezzotti has served since 2024 as Distinguished Professor, Director of the Biomedical Engineering Center, and Director of the Ca' Foscari/Kansai Medical Academic HUB at Kansai Medical University in Osaka, Japan. Prior to these appointments, he spent twenty-four years as Full Professor and Head of the Ceramic Physics Laboratory at the Kyoto Institute of Technology, where he also held senior leadership roles—including seven years as Vice President for International Affairs and later for Collaborative Research in Health Science—and now Emeritus Professor.

A summa cum laude graduate in mechanical engineering from the University of Rome “La Sapienza” (1984), Professor Pezzotti holds six doctoral degrees from leading Japanese universities, spanning engineering, quantum chemistry, orthopedics, immunology, food chemistry, and pharmacy. Fluent in Japanese, he was among the first foreign nationals to obtain a tenured full professorship at a Japanese national university and the first Western-born Trustee Vice President in such an institution.

His academic career includes directing the Research Institute for Nanoscience at the Kyoto Institute of Technology (2002–2012), and Tokyo Medical University, as well as honorary appointments at Ca' Foscari University of Venice and Politecnico of Torino's Japan HUB Kyoto.

Professor Pezzotti is the author of more than 800 scientific papers, three single-authored books, one edited volume, fifteen book chapters, and fourteen patents—including a seminal world patent on nanoscale stress microscopy in the scanning electron microscope. In 2021, he was listed among the top 2% of the world's most influential scientists across all disciplines (Scopus citation indicators). His intellectual property has been licensed by over twenty major international companies.

His contributions have earned him numerous distinctions: Fellowship of the Academy of Science (Bologna Institute) in 2013 for pioneering work in Raman spectroscopy; consecutive City of Kyoto Awards in 2015 and 2016 for advancing the city's international engagement; and in 2017 the prestigious MEXT Prize for Scientific Research—marking the first time a foreign individual received this honor—for his invention of the nanoscale stress microscope and his foundational impact on Japan's industrial sector. In 2021, the President of Italy appointed him Knight of the Order of the Star of Italy.