MindAuthors
INNOVATING MINDS FOR EXCELLENCE

9th World Congress on

# MATERIALS SCIENCE AND ENGINEERING

November 07-08, 2025 | Park Hotel Hong Kong, Hong Kong

**Theme:**

“Shaping the future through expertise and innovations in Materials Science and Engineering”

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| **14:05 - 14:25** | **Title: Interactions of Re and Hydrogen At Γ/Γʹ Interfaces Enhanced Hydrogen-Embrittlement Resistance of Re-Optimized Ni-Based Superalloy**<br>**Tingting Zhao,** *Northwestern Polytechnical University, China* |
| **14:25 - 14:45** | **Title: Empowering oxidation resistance of Cr-coated zirconium alloys via hydrogen-driven interface polymorphic transformation**<br>**Junlei Yin,** *Northwestern Polytechnical University, China* |
| **14:45 - 15:05** | **Title: Exploring the Electric Conductivity of Additively Manufactured Multiphase High-Entropy Alloys**<br>**David Maximilian Diebel,** *Tongji University, China* |

**Refreshment & Coffee - 15:05 - 15:25**

**Oral Presentations**

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| **15:25 - 15:45** | **Title: Simultaneously Achieving Advanced and Heat Treatment Insensitive Strength-Ductility Synergy in an A+B Titanium Alloy Via Tailoring Silicide and Heterogeneous A Precipitates**<br>**Jinhua Dai,** *Northwestern Polytechnical University, China* |
| **15:45 - 16:05** | **Title: Revealing the Materials Genome for Advanced High-Entropy Materials**<br>**Jiaqi Lu,** *Northwestern Polytechnical University, China* |

**Poster Presentations - 16:05 - 17:05**

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| **16:05 - 17:05** | **Title: Evaluation of Nano-mechanical Performance in Hydroxyapatite-selenium-collagen Nanocomposite Coatings on Ti6al4v via Electrochemical Deposition**<br>**Dr. Ali Shanaghi,** *Malayer University, Iran*<br><br>**Title: Comb-shaped anion exchange membrane with segmented hydrophilic/ hydrophobic side chain**<br>**Dr. Tiantian Li,** *Dalian University of Technology, China*<br><br>**Title: Multi-layered electrode architectures for use in the next generation of electrochemical lithium-based energy storage devices**<br>**Prof. Sangho Lee,** *Pukyong National University, Korea*<br><br>**Title: Hydrolase Nanozyme Based On N, O-Tethered Ni In Reduced Graphene Oxide Matrix**<br>**Chen Xuanyu,** *National University of Singapore, Singapore*<br><br>**Title: Computational Design and Mechanistic Analysis of Smart Antioxidant Nanoparticles for UV-Induced DNA Damage Prevention: A Molecular Dynamics Study**<br>**Ms. Chelsey Miguel,** *King Kekaulike High School, USA* |

***** End of Day 2 & Conference *****

# Evaluation of Nano-Mechanical Performance in Hydroxyapatite-Selenium-Collagen Nanocomposite Coatings on Ti6Al4V via Electrochemical Deposition

Ali Shanaghi[1]*, Yanbin Zhao[2]*, Maryam Shafiee[1], Ali Reza Souri[1], Qingdong Ruan[2], Paul K Chu[2]*

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**Abstract**

Titanium alloys like Ti6Al4V are a mainstay in medical implants, thanks to their strength and compatibility with the human body. Still, ensuring they last in the body's harsh environment calls for advanced surface coatings. My research explores the nano-mechanical properties of three coatings—hydroxyapatite (HA), HA-selenium (HA-Se), and HA-selenium-collagen (HA-Se-Col)—applied to Ti6Al4V through electrochemical deposition. I looked at their hardness, toughness, and adhesion, alongside their microstructural features. The HA coating, riddled with 20–25% porosity, offered decent hardness but struggled with toughness due to its brittle, open structure, making it prone to cracking under stress. Adding selenium in HA-Se boosted hardness by tightening the crystallite structure, though adhesion to the alloy didn't improve much. The standout was HA-Se-Col, where collagen worked wonders, cutting porosity to 8–10% and creating a dense, unified coating. Collagen's hydrogen bonds with apatite strengthened the structure, spreading stress evenly and resisting cracks. Scanning electron microscopy revealed HA-Se-Col's tight, flower-like texture, which backed its mechanical strength. These findings show how selenium and collagen team up to refine HA coatings, delivering tougher, harder, and better-bonded surfaces for implants. By enhancing these nano-mechanical traits, HA-Se-Col coatings pave the way for longer-lasting, body-friendly titanium implants, blending clever material design with practical biomedical solutions.

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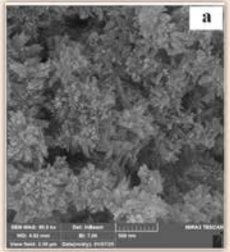
## Abstract

**Titanium alloy Ti6Al4V is widely used in implants, yet its long-term performance depends on durable surface coatings. This study compares the nano-mechanical behavior of hydroxyapatite (HA), HA–selenium (HA–Se), and HA–selenium–collagen (HA–Se–Col) coatings deposited electrochemically on Ti6Al4V. Mechanical tests and microscopy revealed that while pure HA showed moderate hardness but poor toughness due to 20–25% porosity, selenium addition refined the crystallite structure and increased hardness. The HA–Se–Col coating stood out, showing only 8–10% porosity, enhanced adhesion, and superior toughness. Collagen's hydrogen bonding with apatite created a dense, crack-resistant, flower-like microstructure. These results highlight the synergistic role of selenium and collagen in improving HA coatings, leading to stronger, tougher, and more reliable surfaces for next-generation biomedical implants**

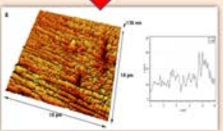
## Methods

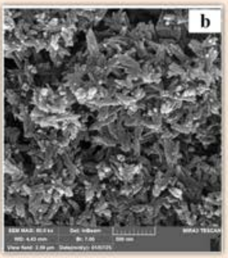
**Nanostructured hydroxyapatite (HA), HA–selenium (HA–Se), and HA–selenium–collagen (HA–Se–Col) coatings were deposited on Ti6Al4V substrates via electrochemical deposition. Titanium plates (10 × 20 × 1 mm) were polished, ultrasonically cleaned, and surface-activated using alkaline, oxalic, and hydrofluoric treatments. The deposition bath contained calcium nitrate, diammonium hydrogen phosphate, and sodium nitrate at pH 4.5 and 37 °C, with sodium selenite (0.04 g) added for Se incorporation. Collagen modification was achieved by immersing dried HA–Se coatings in a collagen solution. Structural and morphological analyses were carried out using XRD, FTIR, and SEM/EDX. Surface topography, roughness, and nano-mechanical properties (hardness and modulus) were evaluated using atomic force microscopy (AFM) and nanoindentation**

## Results

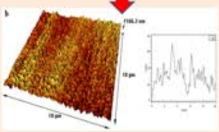


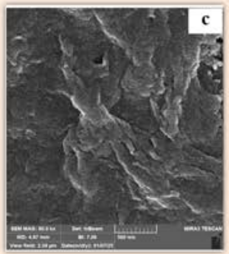

**(a) Nanostructured Hydroxyapatite (HA) Coating**



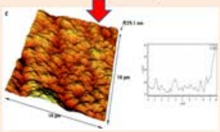


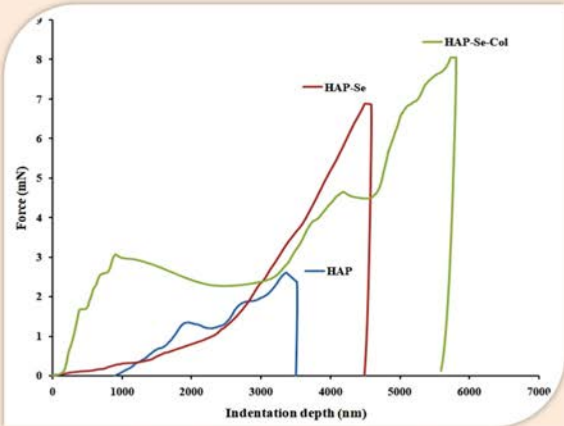

**(b) Nanostructured Hydroxyapatite selenium (HA–Se) Coating**






**(c) Nanostructured Hydroxyapatite selenium–collagen (HA–Se–Col) Coating**






**Nanoindentation curve of Nanostructured coatings**

## Conclusion

**The incorporation of selenium into hydroxyapatite coatings markedly enhanced nano-mechanical performance by increasing hardness and elastic modulus through improved crystallinity and interfacial bonding, while collagen addition, despite slightly reducing hardness, improved toughness, stress distribution, and bioactivity by forming a dense, cohesive, and bio-mimetic matrix. AFM results revealed that the HA–Se–Col coating exhibited higher surface roughness (Ra ≈ 18.8 nm), promoting better cell adhesion and osseointegration. Overall, the synergistic effect of selenium and collagen optimized the balance between stiffness and compliance, resulting in coatings with superior durability, mechanical adaptability, and long-term stability for biomedical implant applications.**

## References

[1] Ou, K.-L., Chung, R.-J., Tsai, F.-Y., Liang, P.-Y., Huang, S.-W., & Chang, S.-Y. (2011). Effect of collagen on the mechanical properties of hydroxyapatite coatings. Journal of the Mechanical Behavior of Biomedical Materials, 4(4), 618-624.

[2] Ali Shanaghi, Babak Mehrjou, Zahra Ahmadian, Ali Reza Souri, Paul K. Chu," Enhanced corrosion resistance, antibacterial properties, and biocompatibility by hierarchical hydroxyapatite/ciprofloxacin-calcium phosphate coating on nitrided NiTi alloy," Materials Science and Engineering: C,Volume 118,2021,111524.