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CENTER FOR DISRUPTIVE MUSCULOSKELETAL INNOVATIONS

Development of Hard Antibacterial (TiN/Ag) Coatings on Orthopedic Instruments Fabricated from Ti-alloys

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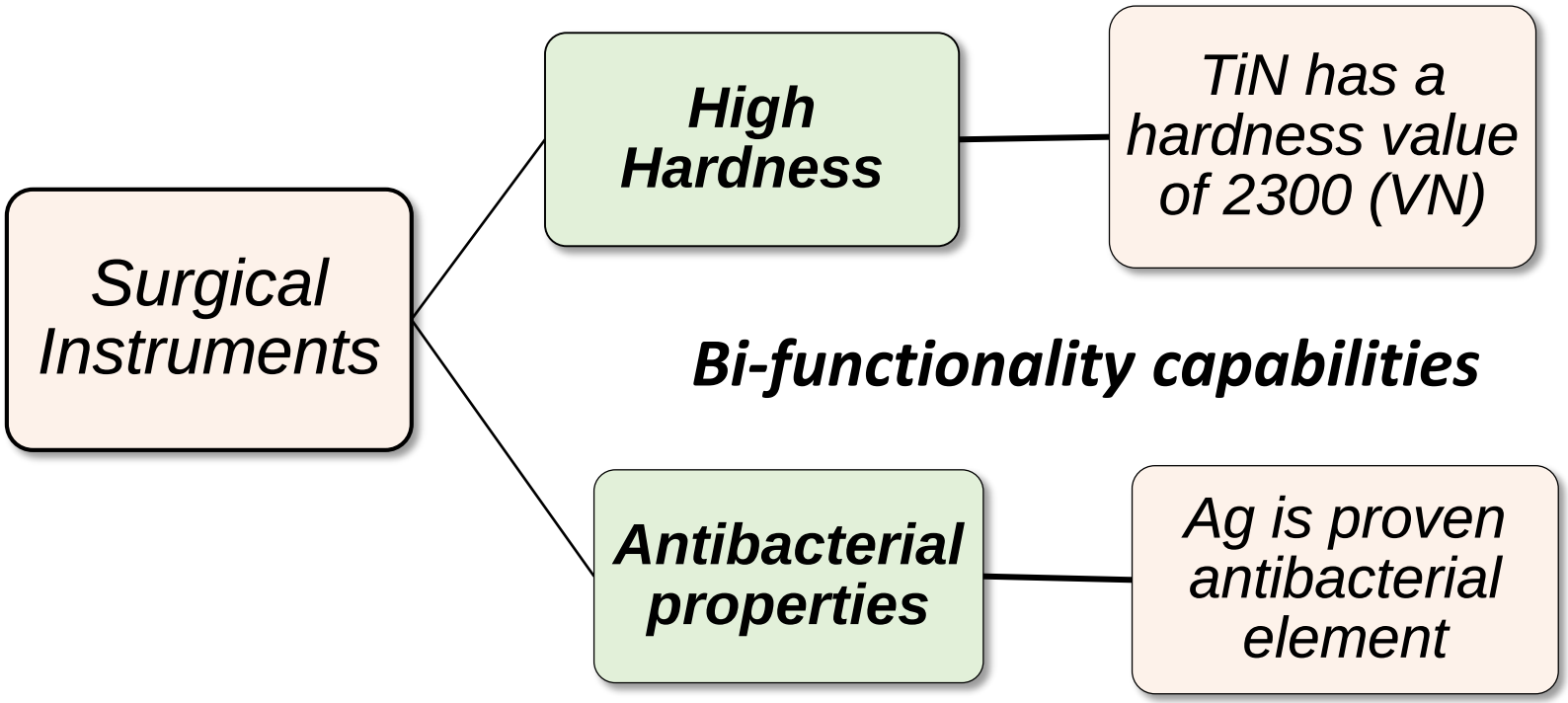
Introduction

Why TiN-Ag coatings ?



Introduction

Magnetron Sputtering (PVD)

- Different materials can be coated on substrates simultaneously and uniformly.
- Makes the coatings compact and bond tightly onto the substrates.
- Different silver Ag contends coatings can be formed by the changing prcess parameters.

The Set-Up

Project Aims

Specific aim 1: To determine and optimize the parameters for magnetron sputtering process to produce TiN/Ag coatings on Ti6Al4V substrates.

Specific aim 2: Examine the antibacterial properties.

Specific aim 3: Determine the impact of repeated autoclave cycles of the coated substrates/instruments on the antibacterial properties.

Methods-Characterization

Ti

TiN coatings

TiN-Ag coatings

Morphology & Phases

- SEM
  EDS & Backscattering
- XRD

Antibacterial Assays

- Zone of Inhibition
  Ag^+ release kinetics
- Two-color fluorescence assay

Nano-hardness & Adhesion

- Nano-indentor
  Hardness test &
  Scratch test

Desired TiN-Ag coatings

Optimize parameters

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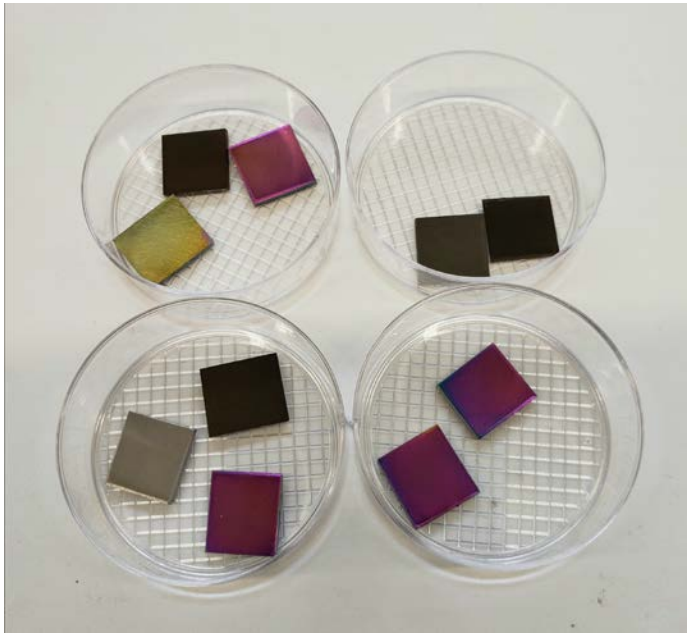
Project Progress

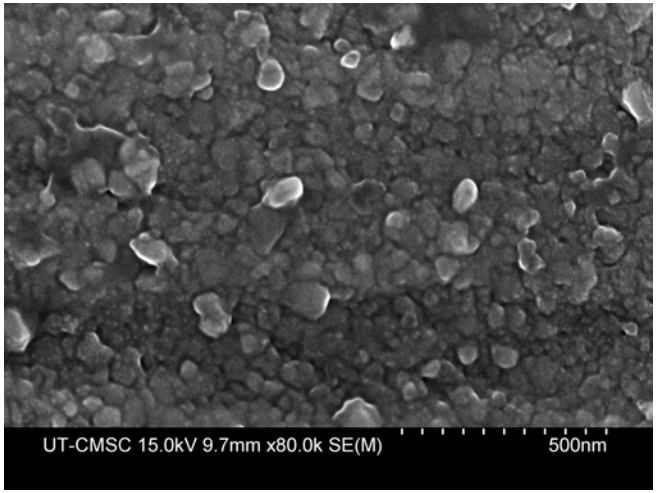
Samples

- Polished pure Ti plates
- TiN coatings on Ti substrates with different parameters
- TiN-Ag coatings on Ti substrates

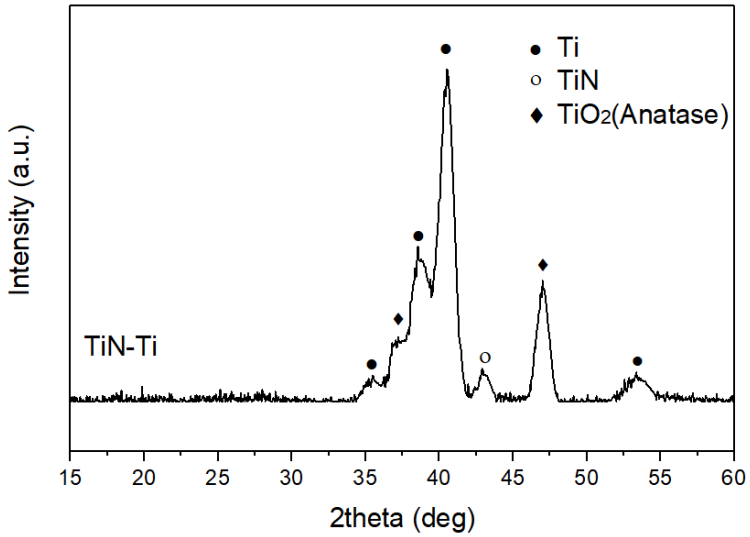


Project Progress

TiN coating on Ti substrate



SEM image shows compact coating grains.

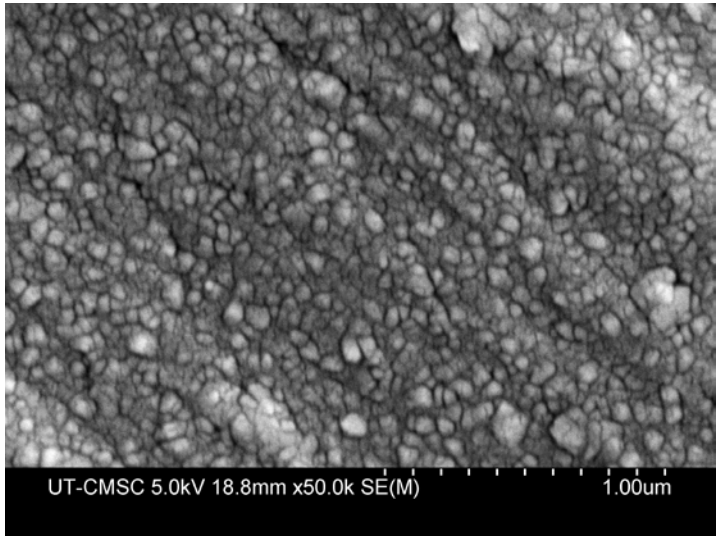


XRD pattern

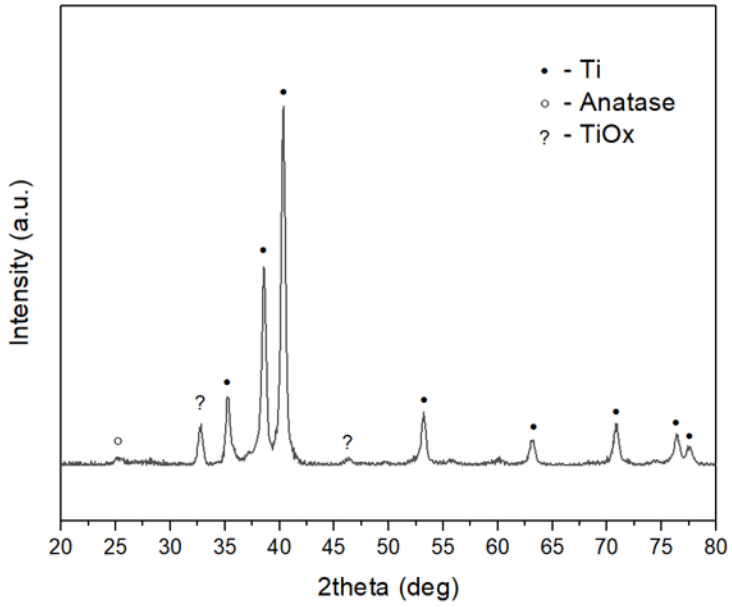
Rf Power	Ar/N_2	Pressure	Silver added	Substrate heated
150W	1/1	4.5Pa	No	Unheated

Project Progress

TiN coating on Ti substrate



SEM image shows compact coating grains.



XRD pattern

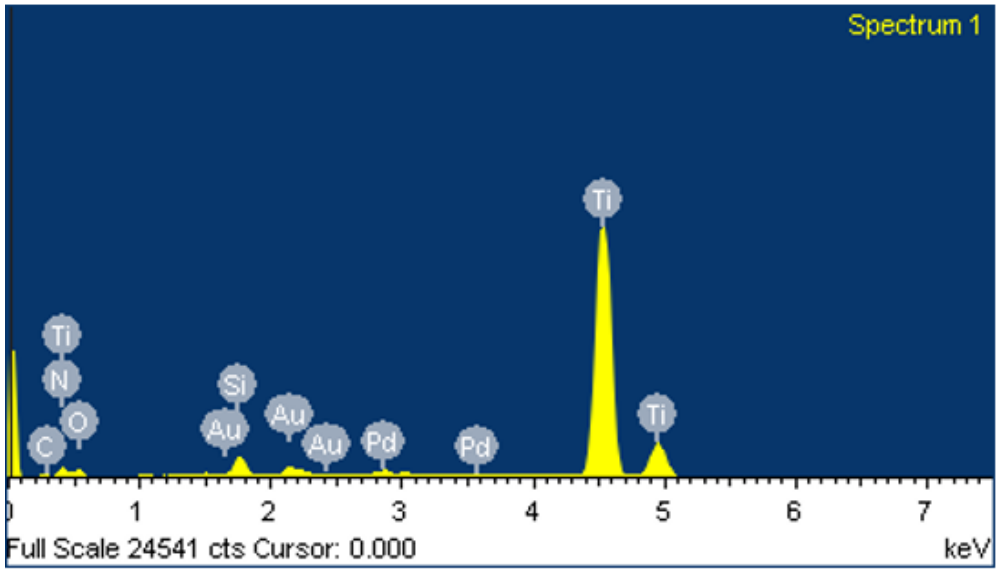
Rf Power	Ar/N_2	Pressure	Silver added	Substrate heated
250W	1/1	4.5Pa	No	Unheated

Project Progress

TiN coating on Ti substrate

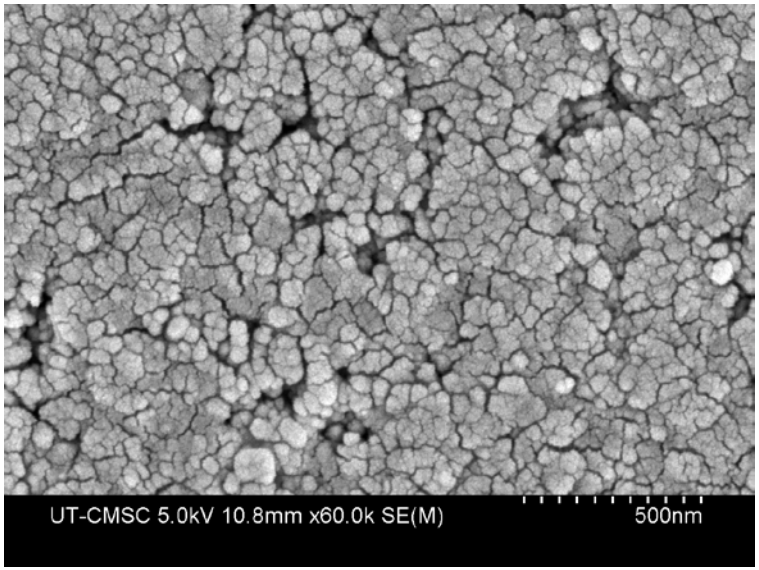
EDS result

Element	Weight%	Atomic%
C K	4.41	12.16
N K	1.28	3.03
O K	15.14	31.36
Si K	2.37	2.80
Ti K	71.64	49.55
Pd L	1.60	0.50
Au M	3.56	0.60
Totals	100.00	

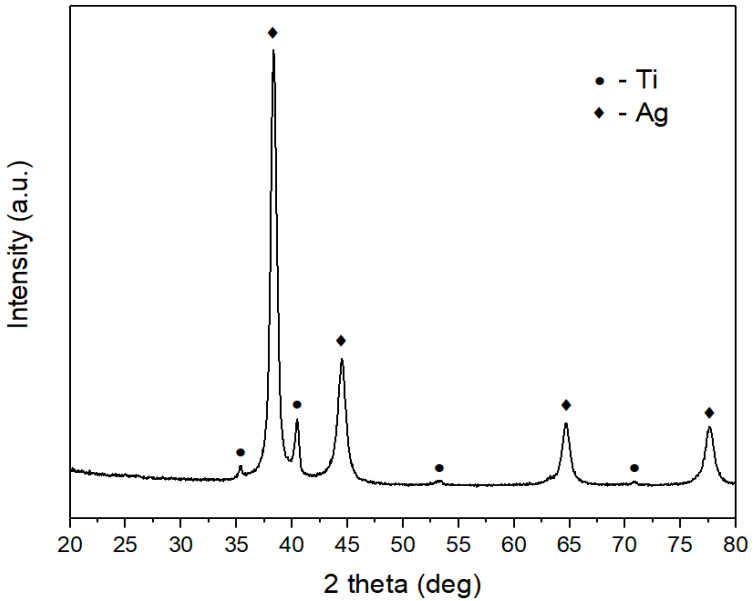


Project Progress

TiN-Ag coatings on Ti substrate



SEM image



XRD pattern

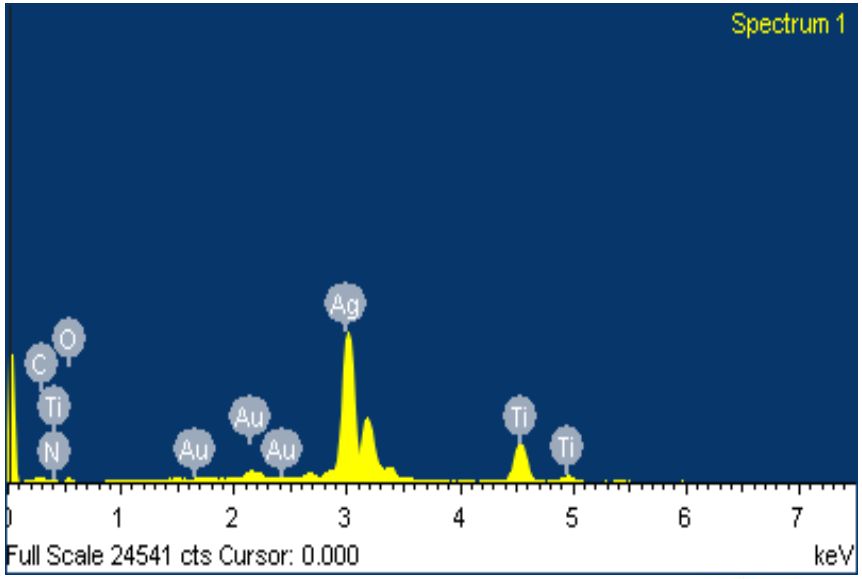
Rf Power	Ar/N_2	Pressure	Silver added	Substrate heated
250W	1/1	4.5Pa	Yes	Unheated

Project Progress

TiN-Ag coatings on Ti substrate

EDS result

Element	Weight%	Atomic%
C K	1.99	8.83
N K	4.41	16.78
O K	6.98	23.28
Ti K	15.05	16.76
Ag L	66.84	33.06
Au M	4.73	1.28
Totals	100.00	



Project Progress

Antibacterial Properties

- Zone of inhibition method can show the antibacterial property and Ag^+ release kinetics of coatings.

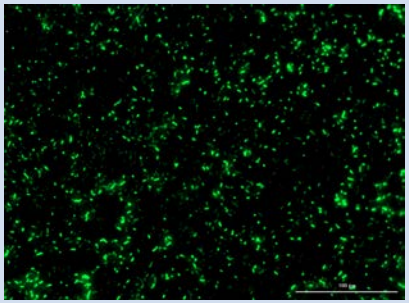
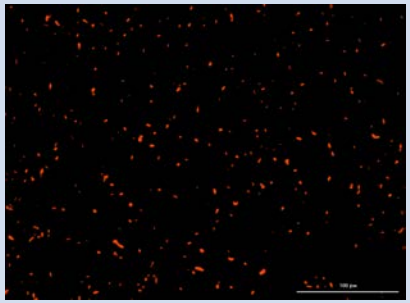
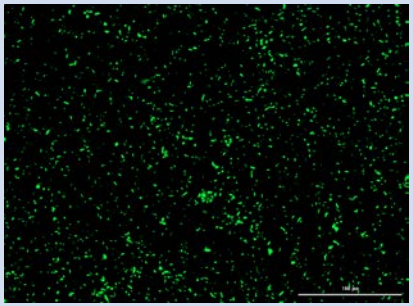
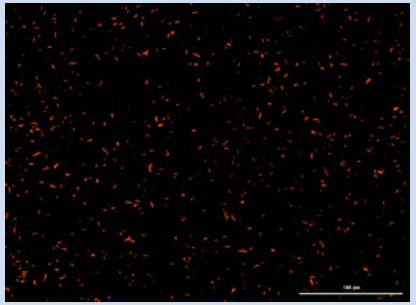
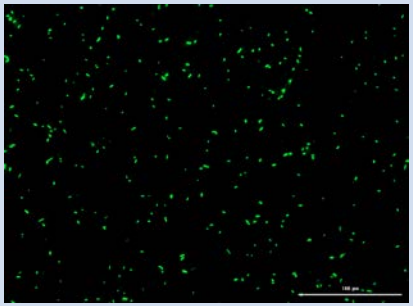
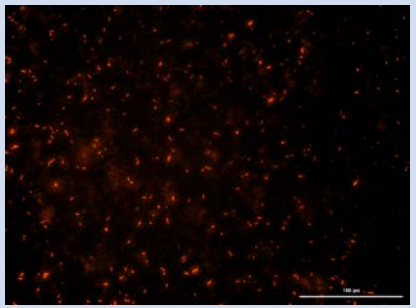
  No antibacterial property was shown from ZOI method.

- Two-color fluorescence assay was used to characterize the contact killing property of coatings.

LIVE/DEAD BacLight Bacterial Viability Kit L7012 (Syto9/PI) was employed as dyes and the stained samples were analyzed by Cytation 5.

The results showed that Ag doped coatings process contact killing antibacterial property.

Project Progress

Samples	Green (syto9)	Red (propidium iodide)
TiN(150W)		
TiN(250W)		
TiN-Ag(250W)		

Next Step & Timeline

- Take nano-hardness and scratch test on new sample to see if it contains TiN. (March 2018)
- Investigate the antibacterial properties of nanostructured particles, TiO2 and Ag. (April - May 2018)
- Reduce Ag content and find out the best parameters for making golden color TiN coatings. (April - June 2018)
- Determine the impact of repeated autoclave cycles of the coatings on the antibacterial properties. (June – July 2018)
- Data analysis and final reports. (Oct 2018)

Hysitron TI-950
TriboIndenter

Q & A

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Thank You

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