Методи вивчення якості імплантів

«Modern European trends in biomedical higher education: Bionanomaterials.» № 620717-EPP-1-2020-1-UA-EPPJMO-MODULE

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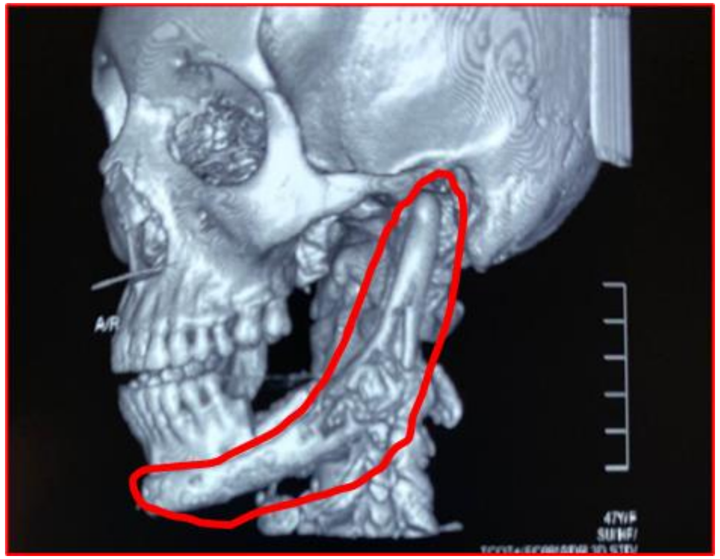
Functional surfaces of bone implants is stratergy of new generation of the biomaterials



Surface modification

HYDROPHILICITY
PROTEIN ADSORPTION

CELL PROLIFERATION

TISSUE FORMATION

ANTIBACTERIAL PROPERTIES

EUBiomt

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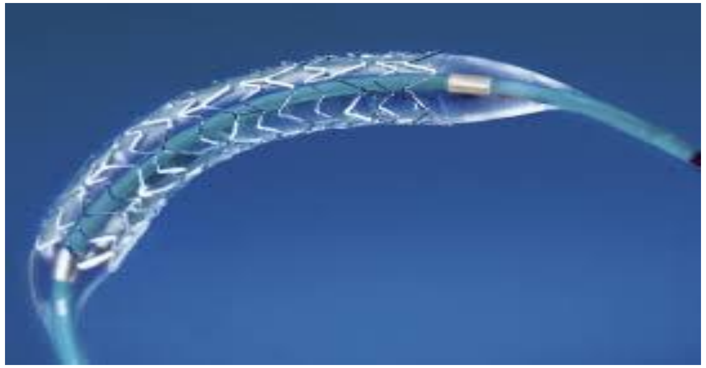
Mg and its alloys as degradable materials

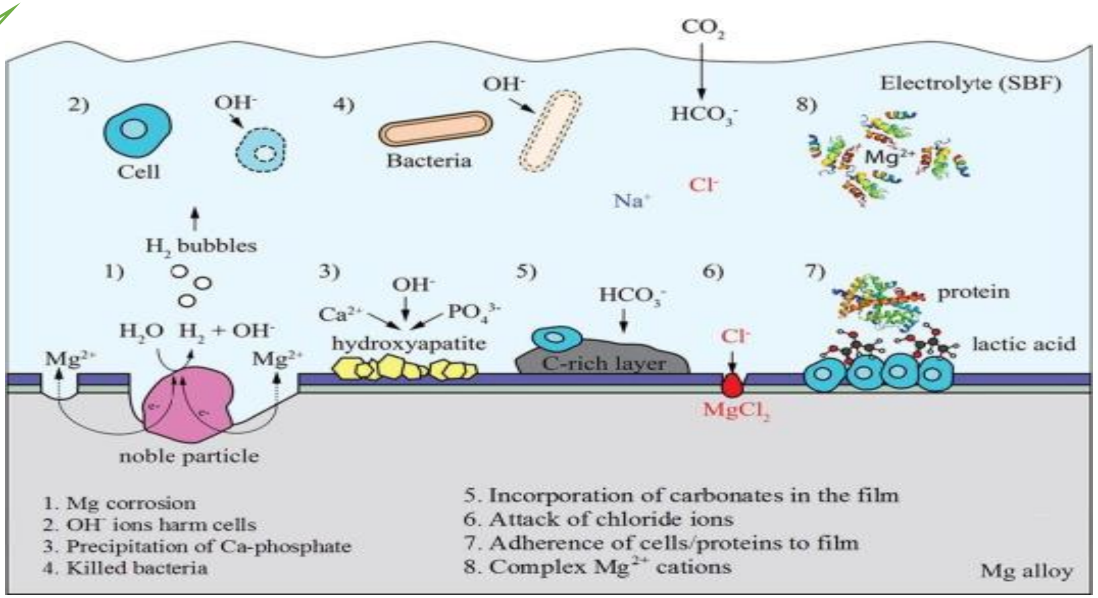


Application

(a) cardiovascular stents
(b) screw
(c) microclip for laryngeal microsurgery
(pure magnesium)
(a) biodegradable orthopedic implants
(b) wound-closing devices

Advantages

- ProperYoungs modulus
- Natural degradability
- Good biocompability
- Good osteopromotive property



https://doi.org/10.1016/j.matdes.2019.108259

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СумДУ

Properties of biomaterials for medical applications. Steps involved in the translation of newly developed biomaterials.

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Biocompatability

- Promoting biological tissue for implant integration
- Promoting cell adhesion
- Providing pathways for vascularization
- Noncarcinogenesis, Nopyrogenicty, Nontoxicity, and nonallergic response

Sterilizability

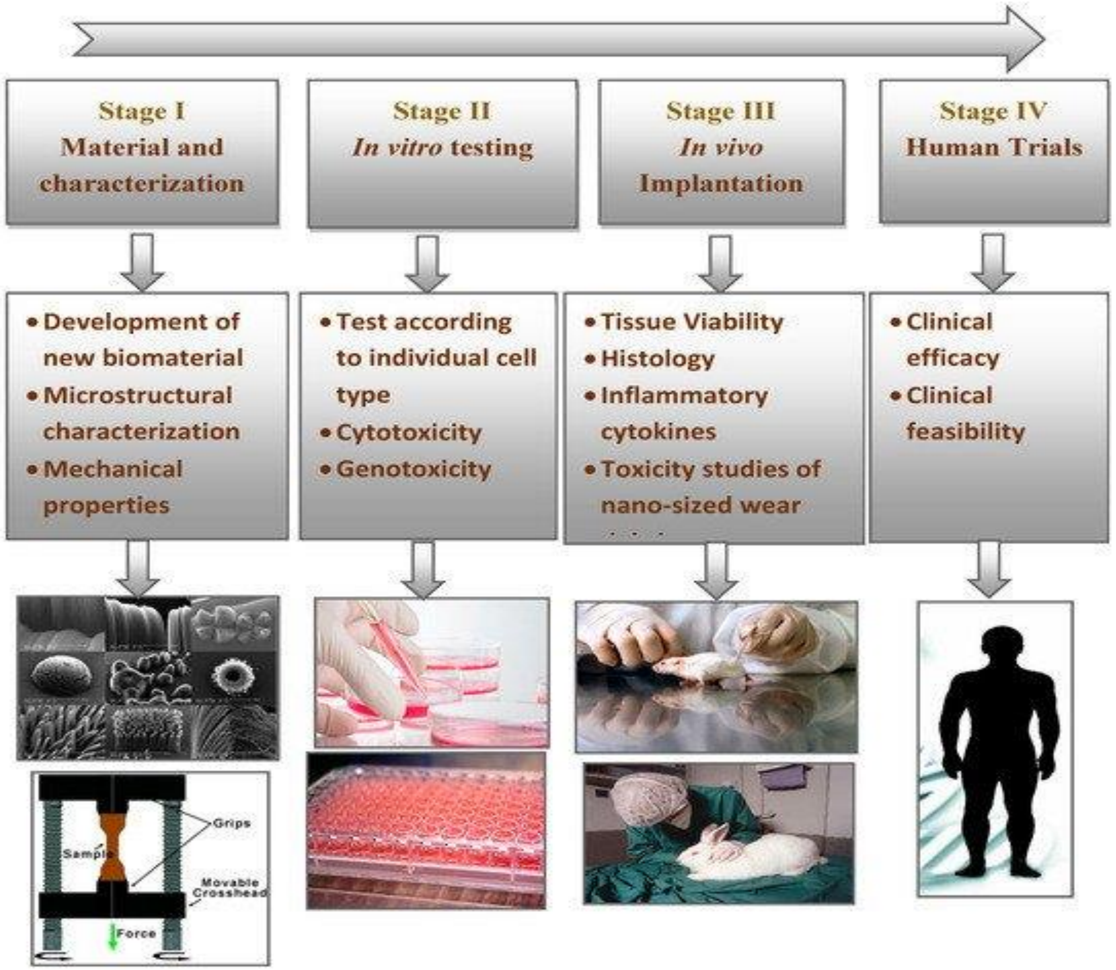
- Ability to undergo sterilization
- Auto clave, and dryheating
- Ethylenoxide gas and radiation

Functionability

- Modulus of elasticity for the stiffness fo the material
- Ultimate tensile strength to withstand a load
- Dimensional accuracy on economically fabrication process

Manufacturability

- Ease of molding
- Undergo extrusion process
- Machinability
- Ability for fiber forming



Materials **2020**, *13*(1), 92; https://doi.org/10.3390/ma13010092

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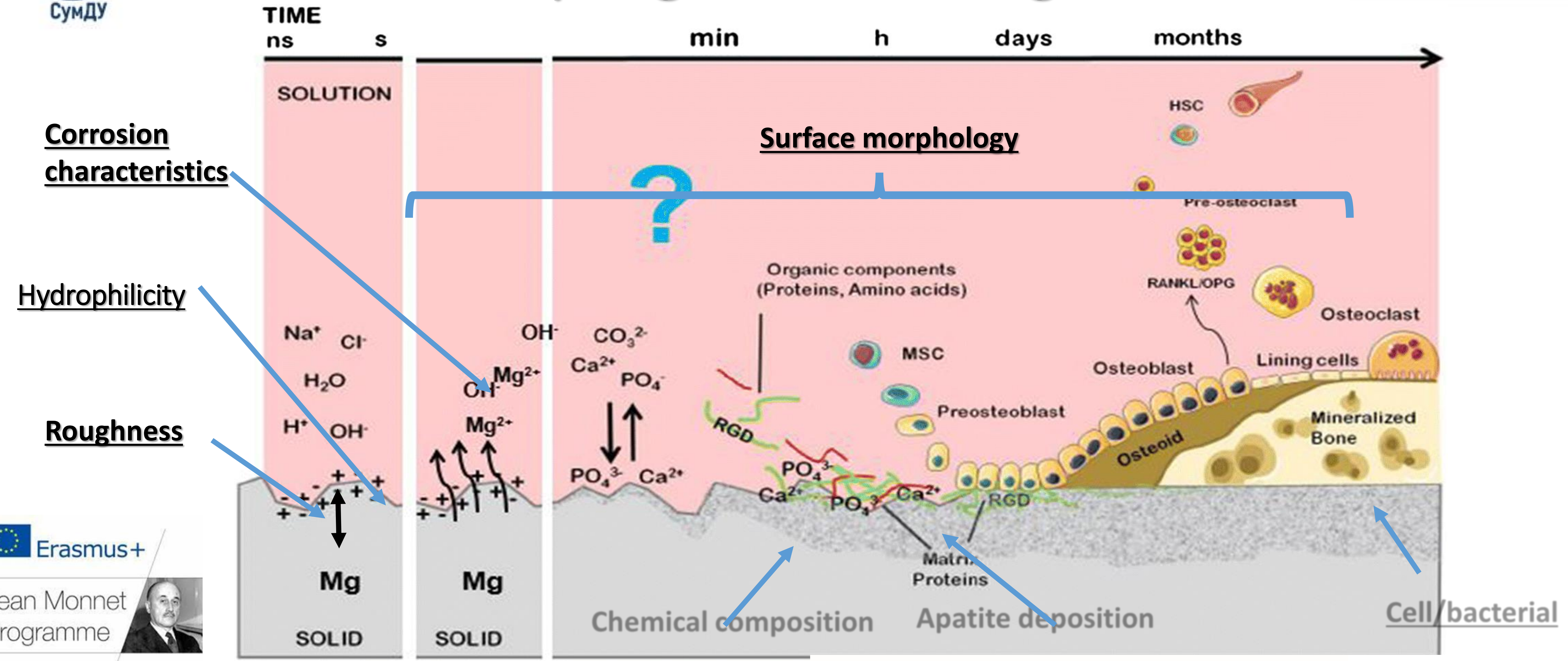
What can be measured when analyzing oxide coating surface?



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Materials and Methods

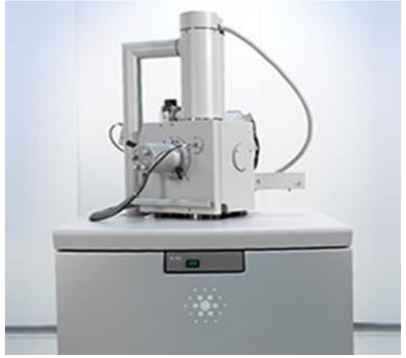
Sample code	Composition of the bath electrolyte
Bath electrolyte 1 (sapmle S1)	10g/L $Na_2S_iO_3$ + 5g/L NH_4F + 10g/L NaOH
Bath electrolyte 2 (sapmle S2)	10g/L Na_2HPO_4 + 5g/L NaOH

- ***Plasma Electrolytic Oxidation (PEO)***
- ***Scanning Electron Microscopy (SEM)***
- ***SBF Immersion Test***
- ***Contact Angle Measurement (CA)***
- ***Roughness Measurement***
- ***Bacterial adhesion assay***

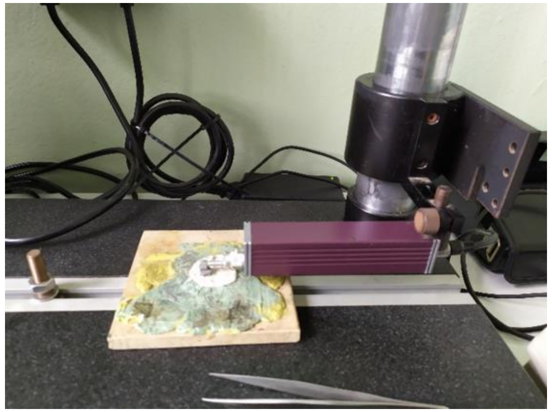
Samples

CA

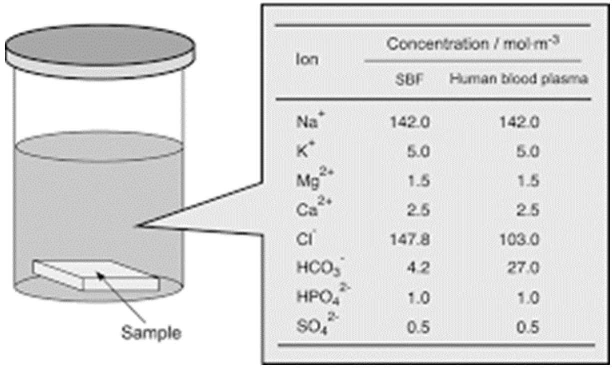
SEM



Roughness measurement

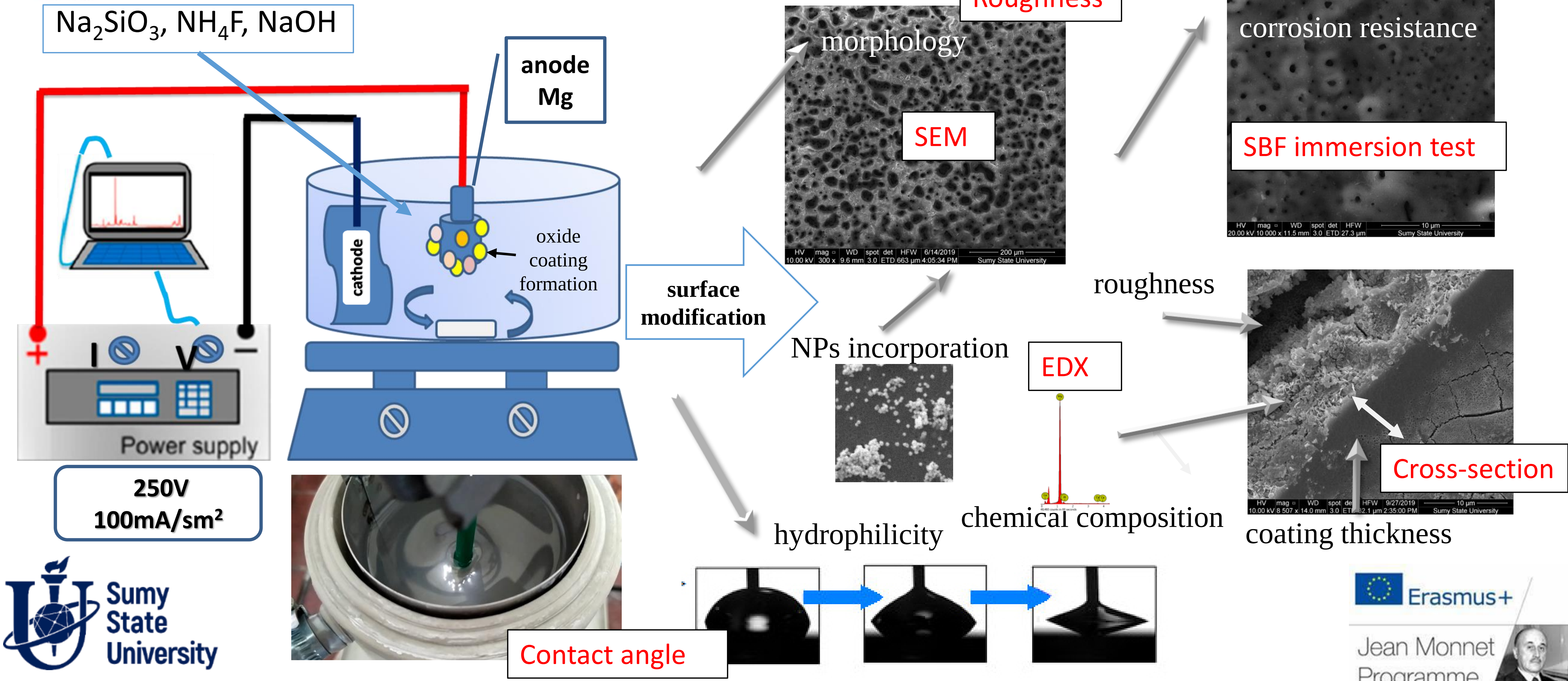


SBF immersion test

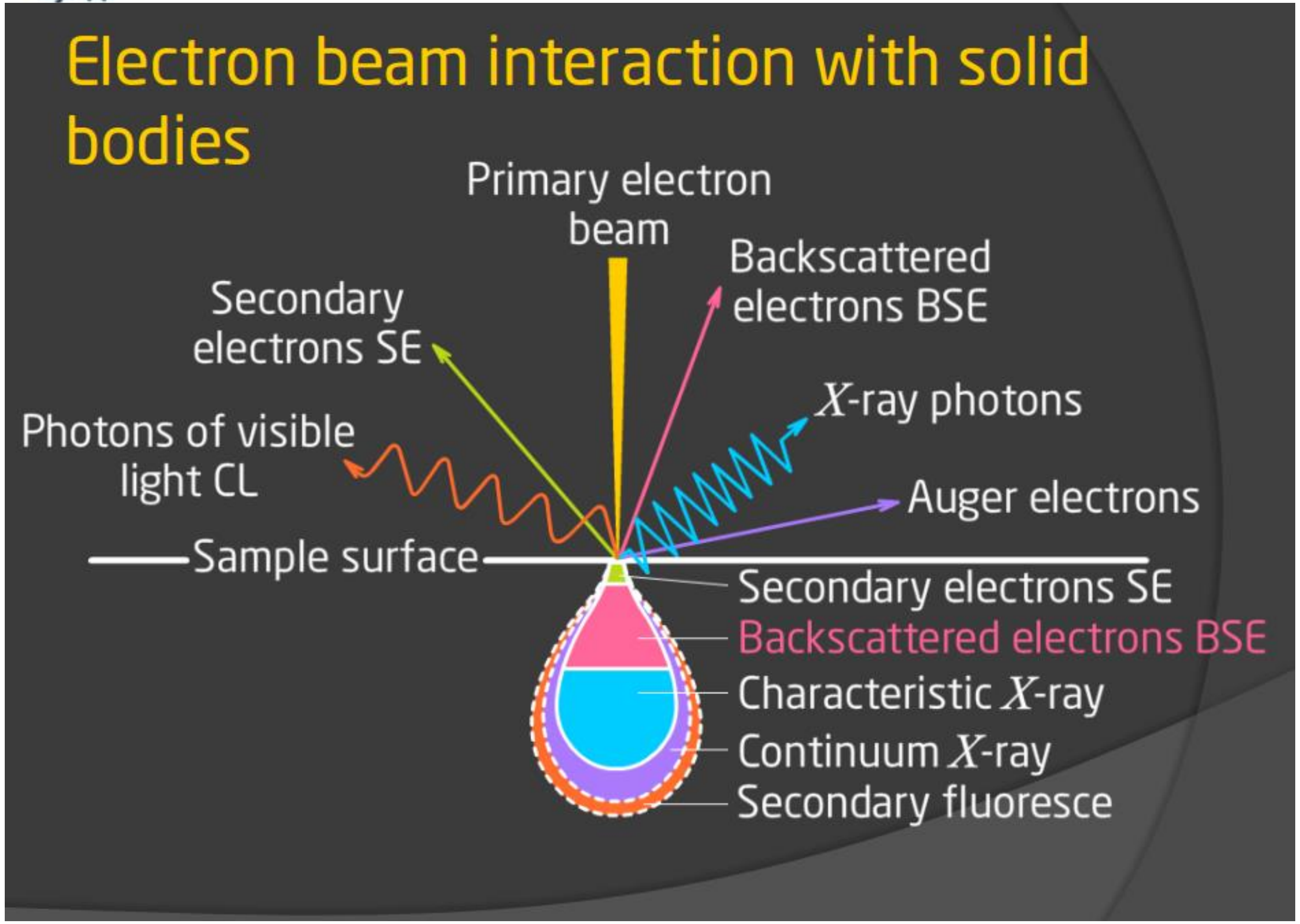


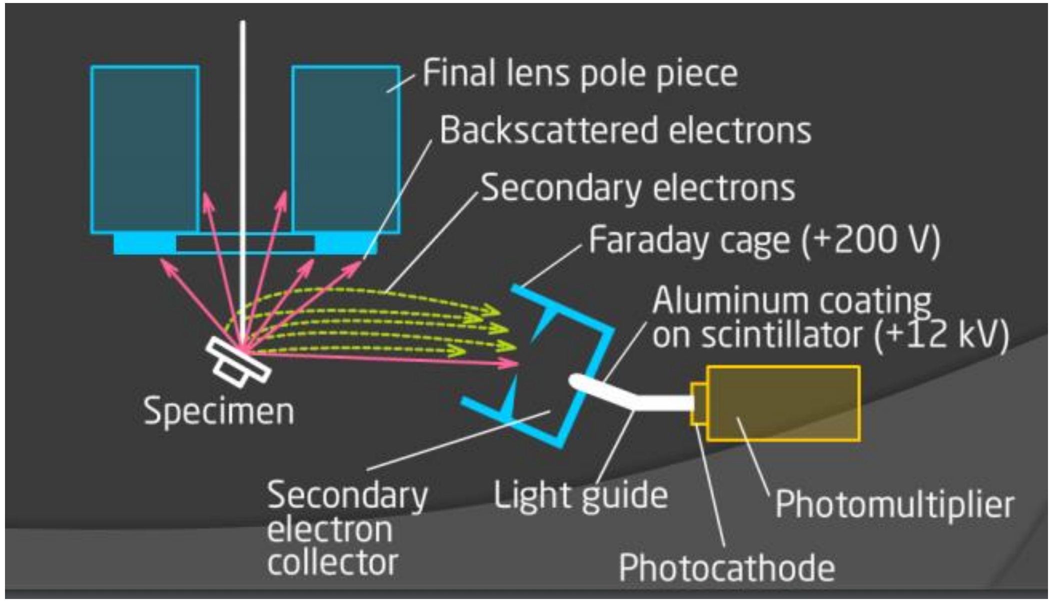
Plasma Electrolytic Oxidation (PEO)

The **aim** of this study was to compare the effect of the silicate and phosphate-based electrolytes on the morphology structure and bacterial adhesional properties of coatings obtained by PEO on a pure Mg surface.



The beam is hitting the sample. It knocks off some secondary electrons from the sample. And we have a detector sideways.
So, it collects it and measures the signal.





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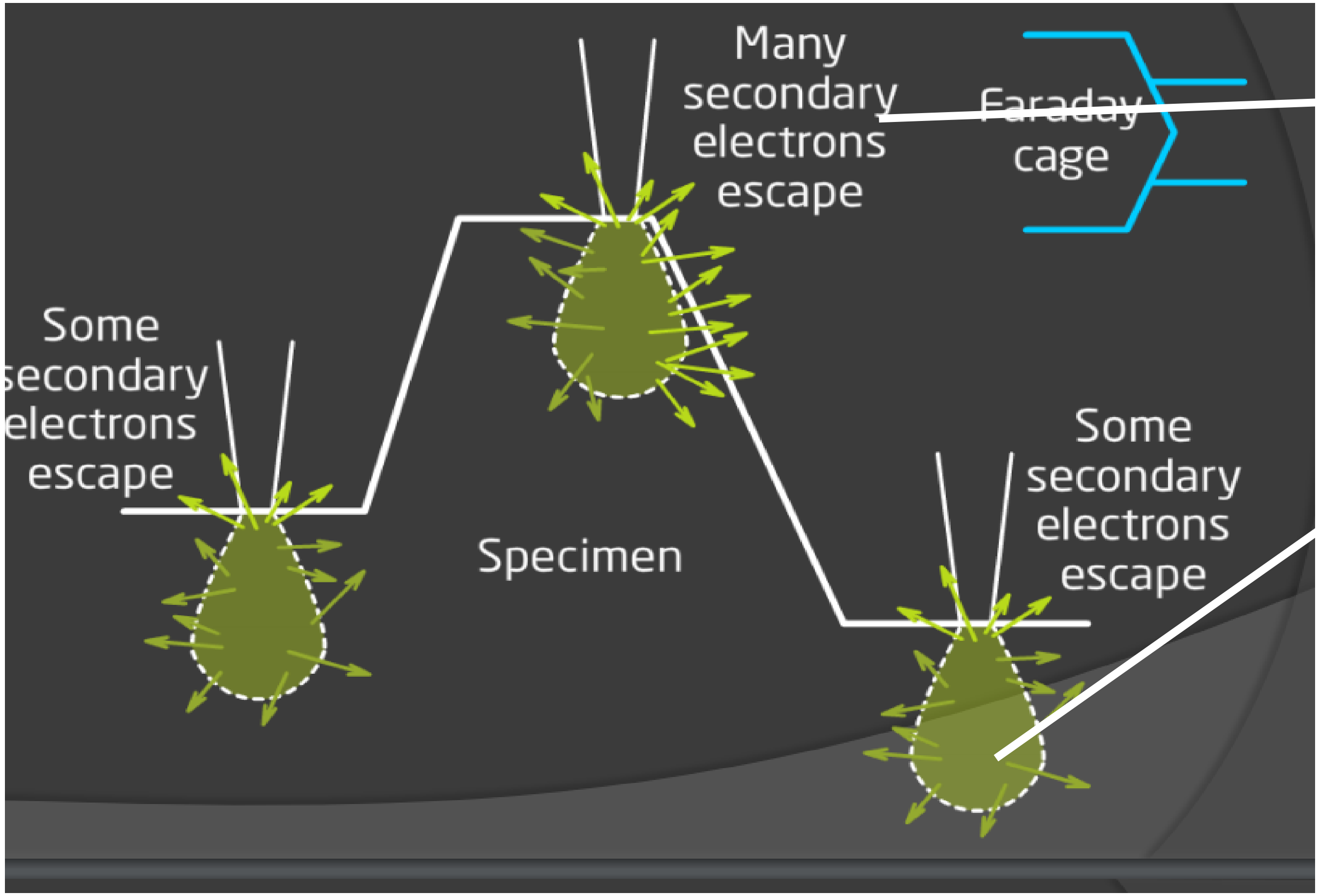
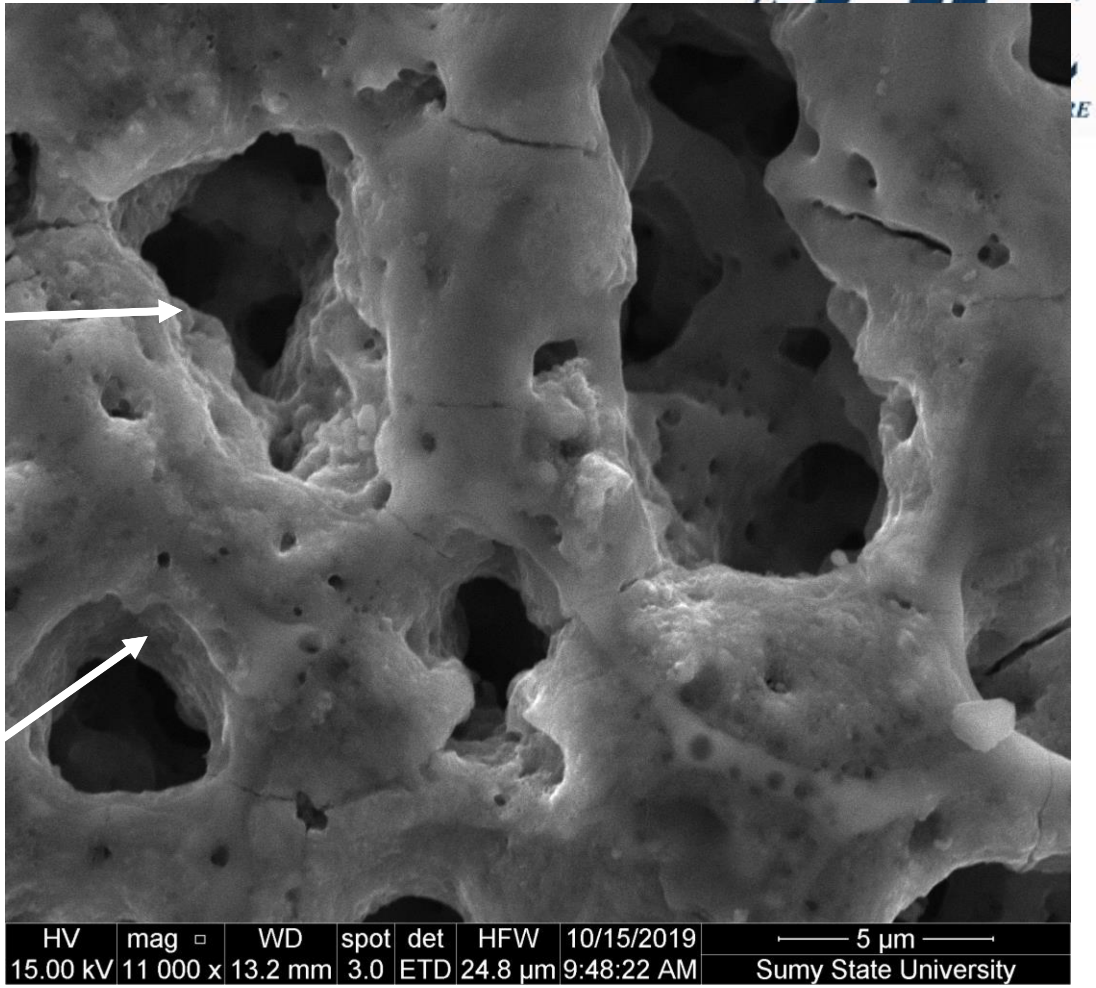
The lighter area on the sample is closer to the detector from which the electrons can go to the detector easier.





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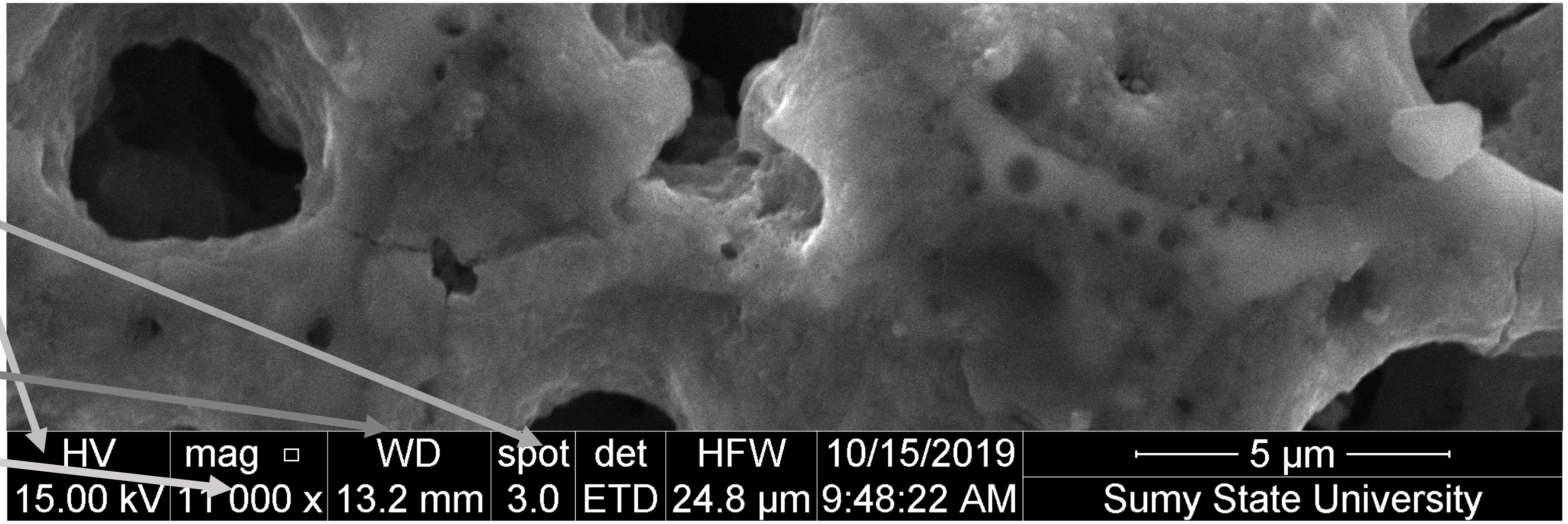
Basic parameters

To obtain a good quality image you must predict and think about all the parameters at the same time.

- Accelerating voltage
- Beam current
- Scanning speed
- Working distance
- Scanning area size
- Image resolution



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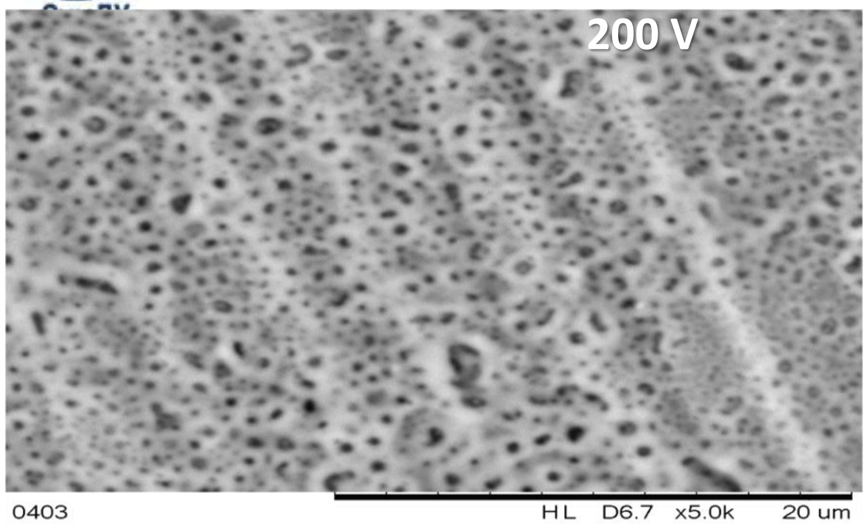
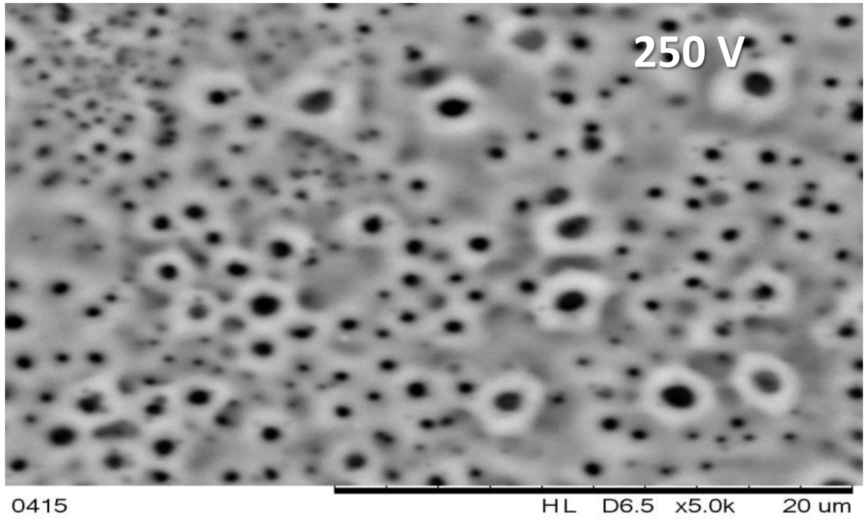
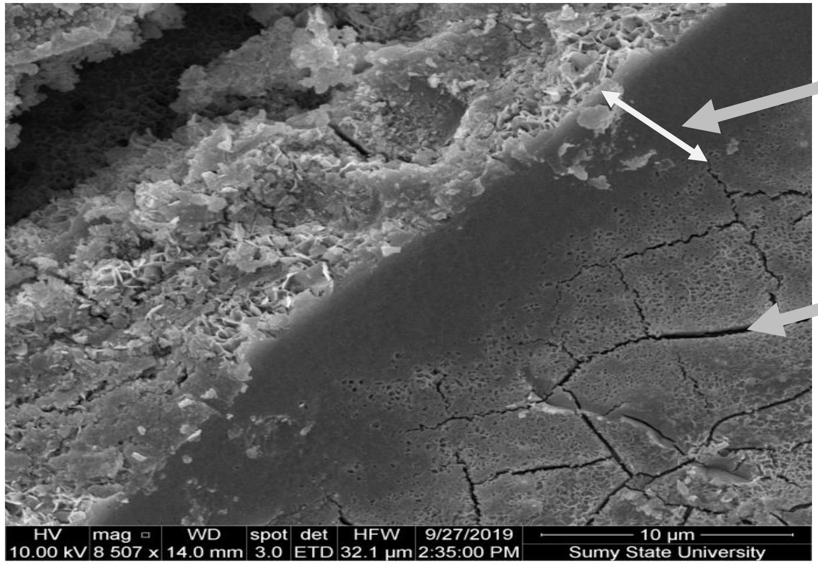
SEM

Surface morphology





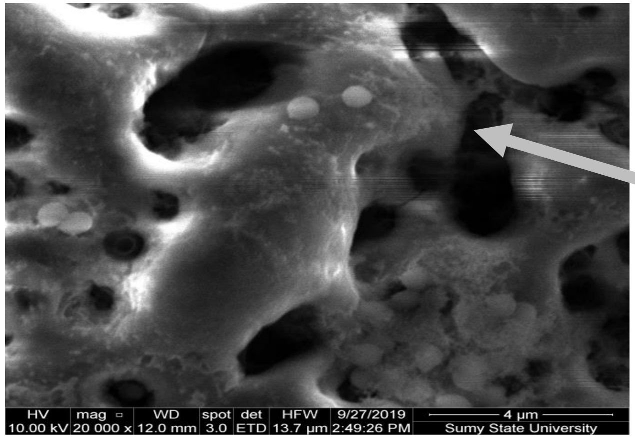
Cross section



Coating thickness

Corrosion features

Adhesion properties



200V	250V
Pore number, N/μm^2	
0,675	0,225
Pore size, µm	
0,43±0,16	1,073±0,27

Bacterial cell adhesion

S. aureus

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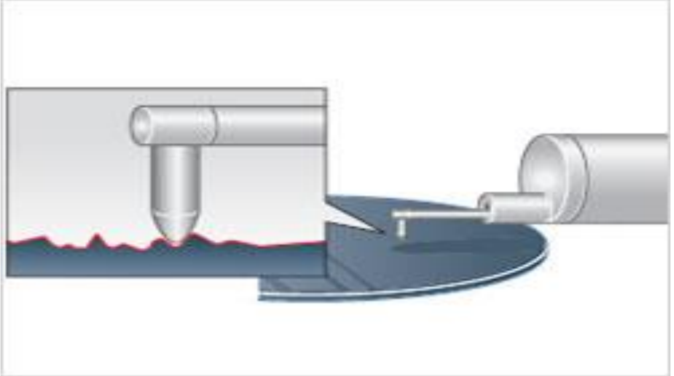
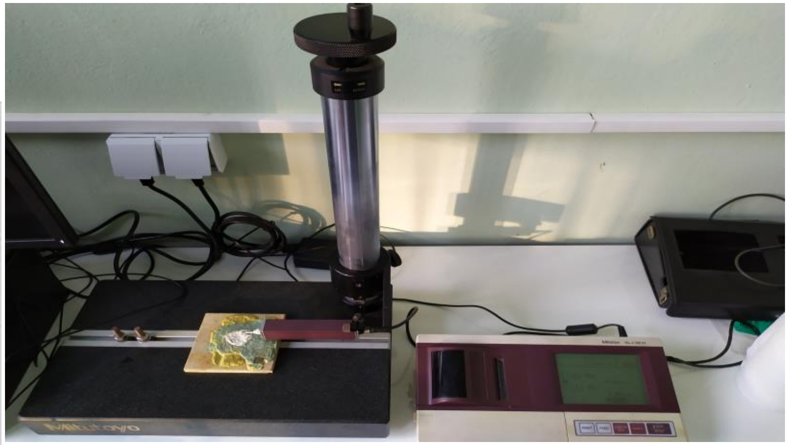
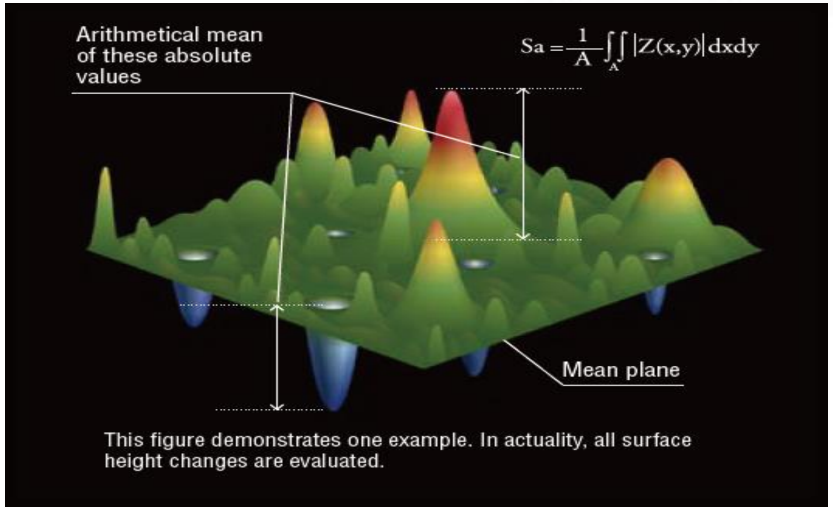
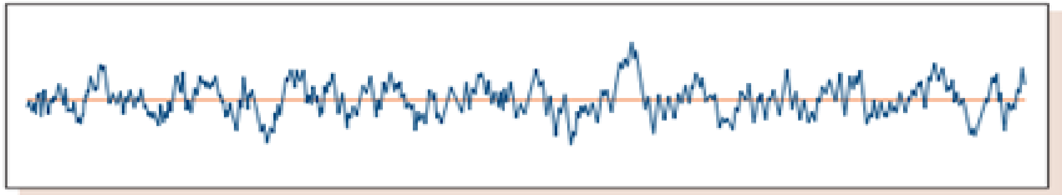
Surface roughness can be measured by contact type 2D and non-contact type 3D







Roughness is a measurement of the small-scale variations in the height of a physical surface. It consists of surface irregularities which result from the various machining process. These irregularities combine to form surface texture.



The roughness profile with its mean line (high-pass filtering of the primary profile with a cut-off wavelength of λc)

Ra expresses, as an absolute value, the difference in height of each point compared to the arithmetical mean of the surface.

Rz is defined as the sum of the largest peak height value and the largest pit depth value within the defined area.

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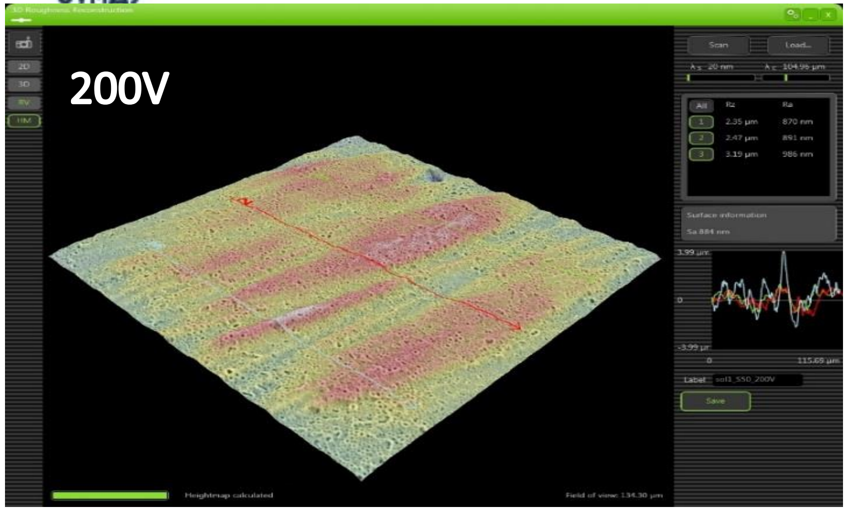
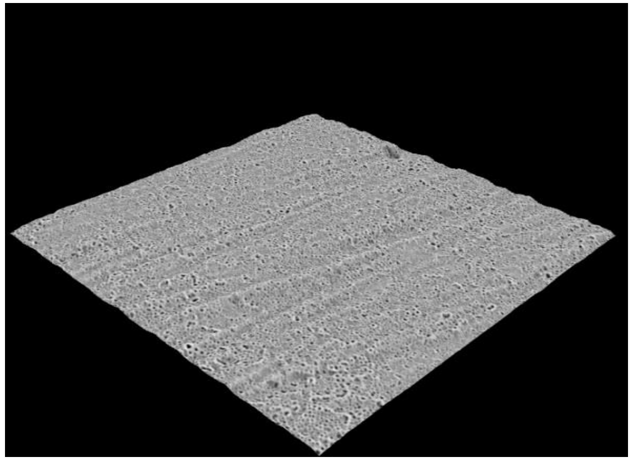
Roughness measurements

3D

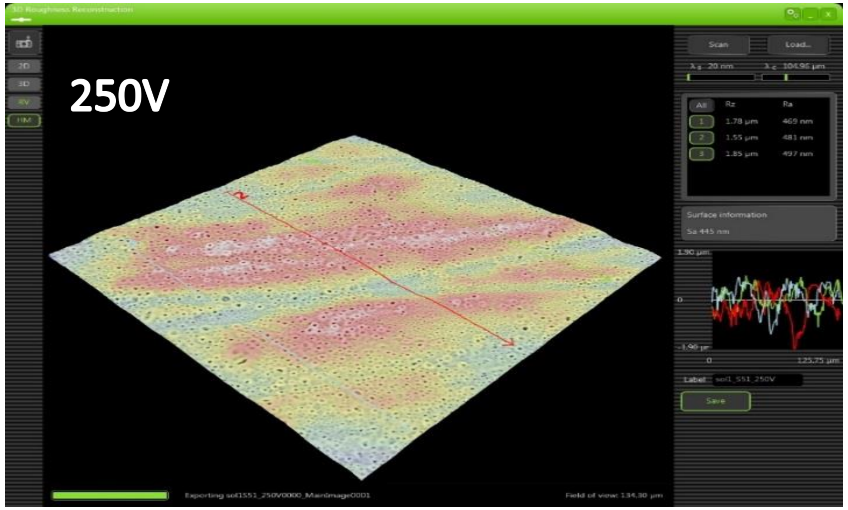
2D

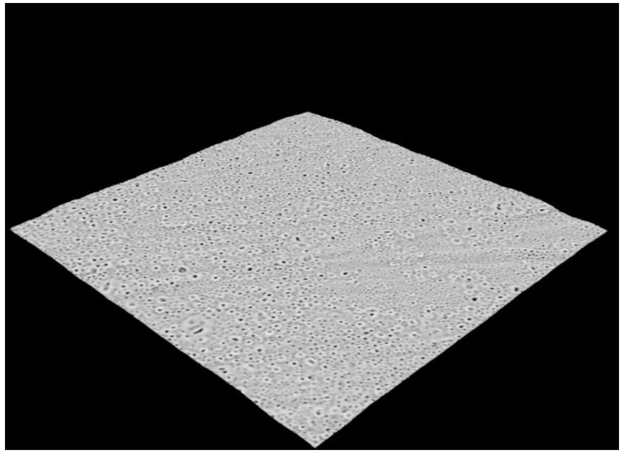




Rz = **3.01** (μm)

Ra = **430.0** (nm)





Rz = **2.83** (μm)

Ra = **393.3** (nm)

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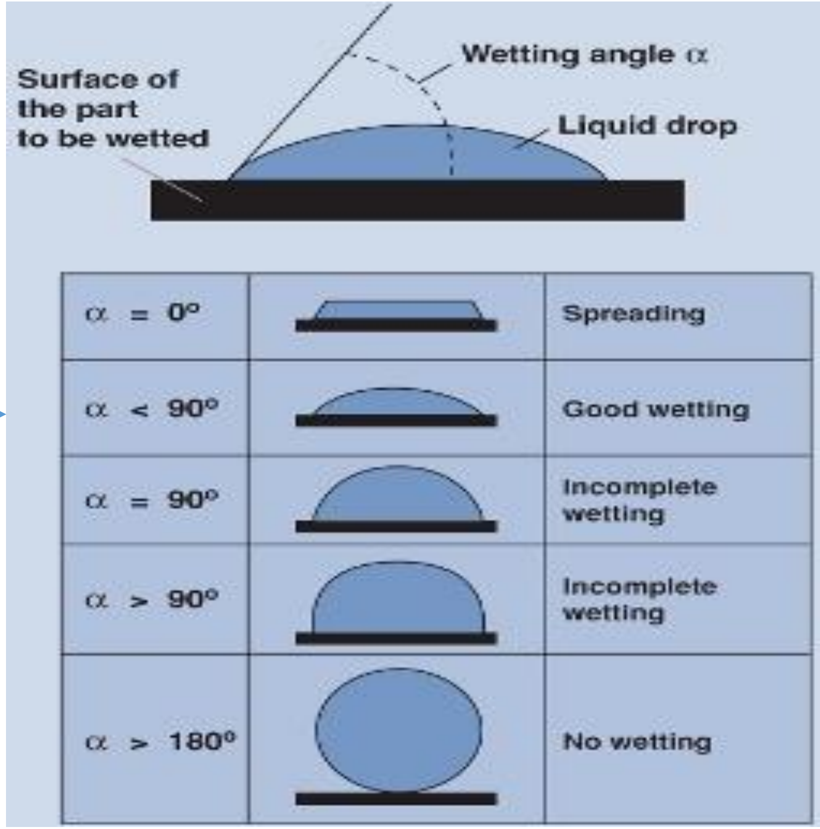
Other methods of surface analyses

CA

-200V – 26.22°

-250V – 22.7°



EDX (elemental composition)

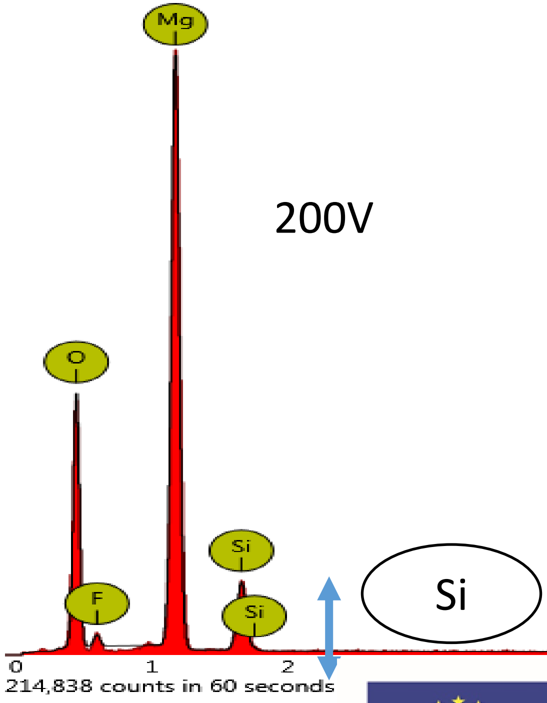
The main crystalline phase - MgO

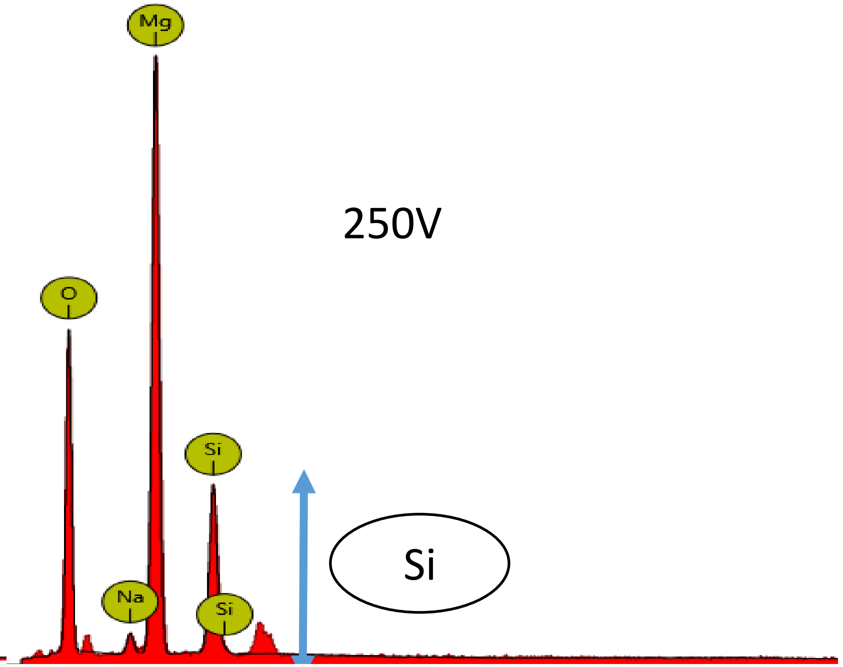
The value of F - 3.41±0.36%

The Si weight percentage of samples:

200 V - 8.3±0.08%

250 V - 15.16±0.09%





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General characterization method

❖ **Microscopy**

1- Scanning Electronic Microscopy (SEM)

2- Transmission Electron Microscopy (TEM)

3- Scanning Tunneling Microscopy (STM)

❖ **Spectroscopy**

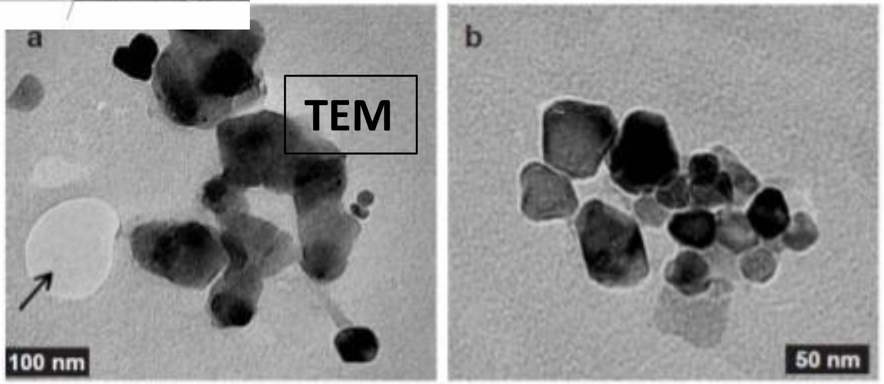
1- X-ray Diffraction (XRD)

2- Small Angle X-ray Scattering (SAXS)

3- X-ray Photoelectron Spectroscopy (XPS)

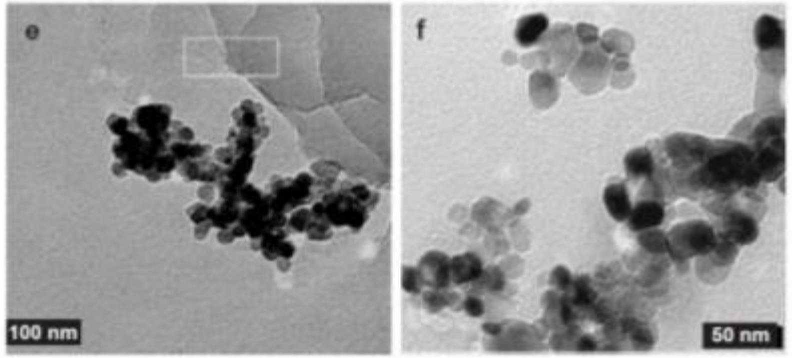
4- UV-vis spectroscopy

5- FT-IR spectroscopy



Large Ceria Nanoparticles ←

Small Ceria Nanoparticles →



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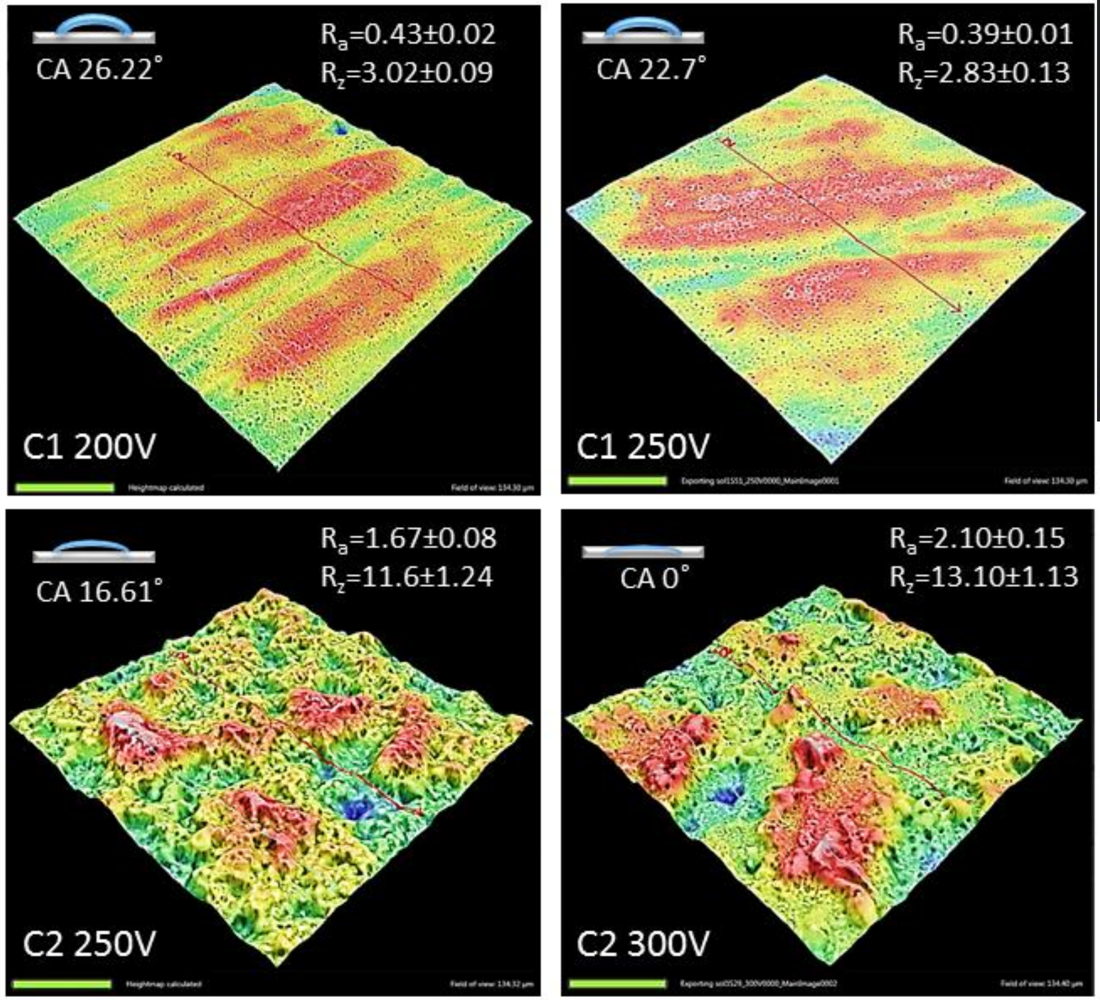

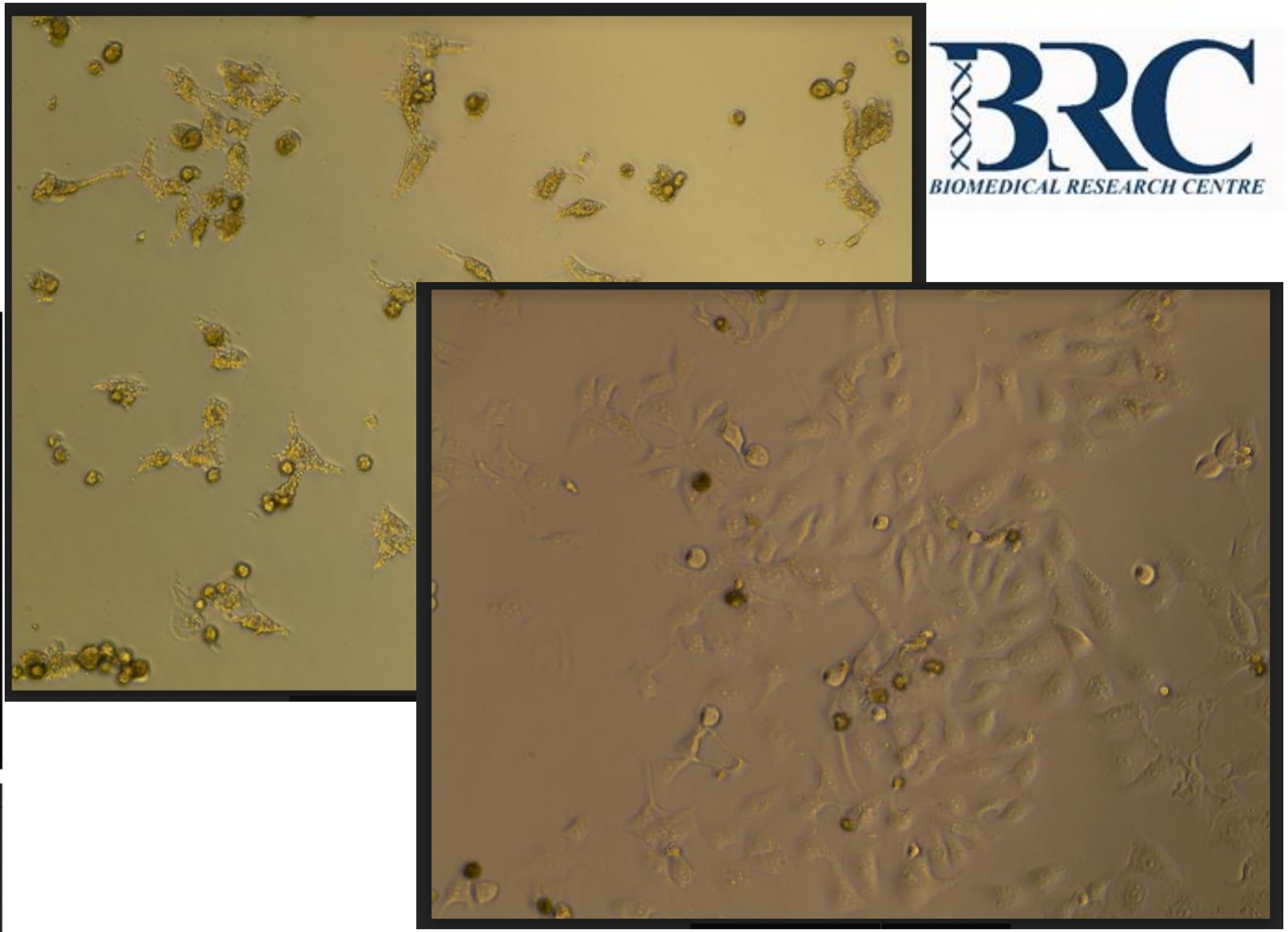

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- Thank you for attention!

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