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The effect of 3D printing parameters and heat treatment on the metallurgical and mechanical properties of Ti alloys

PhD Student: Hassanen Jaber

Supervisor: Tunde Kovacs

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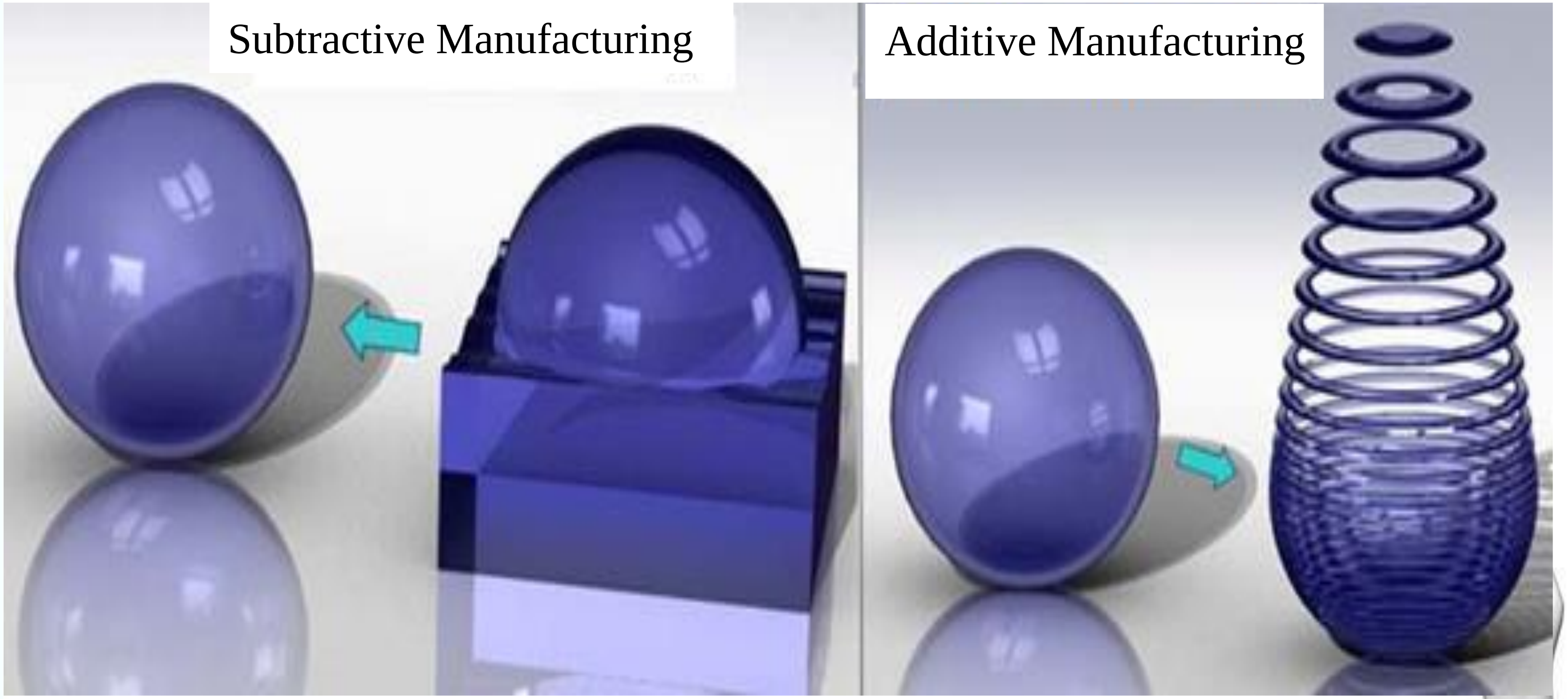
Manufacturing Processes

1. Subtractive (conventional/traditional) manufacturing process
2. Additive manufacturing process (AM)/3D printing

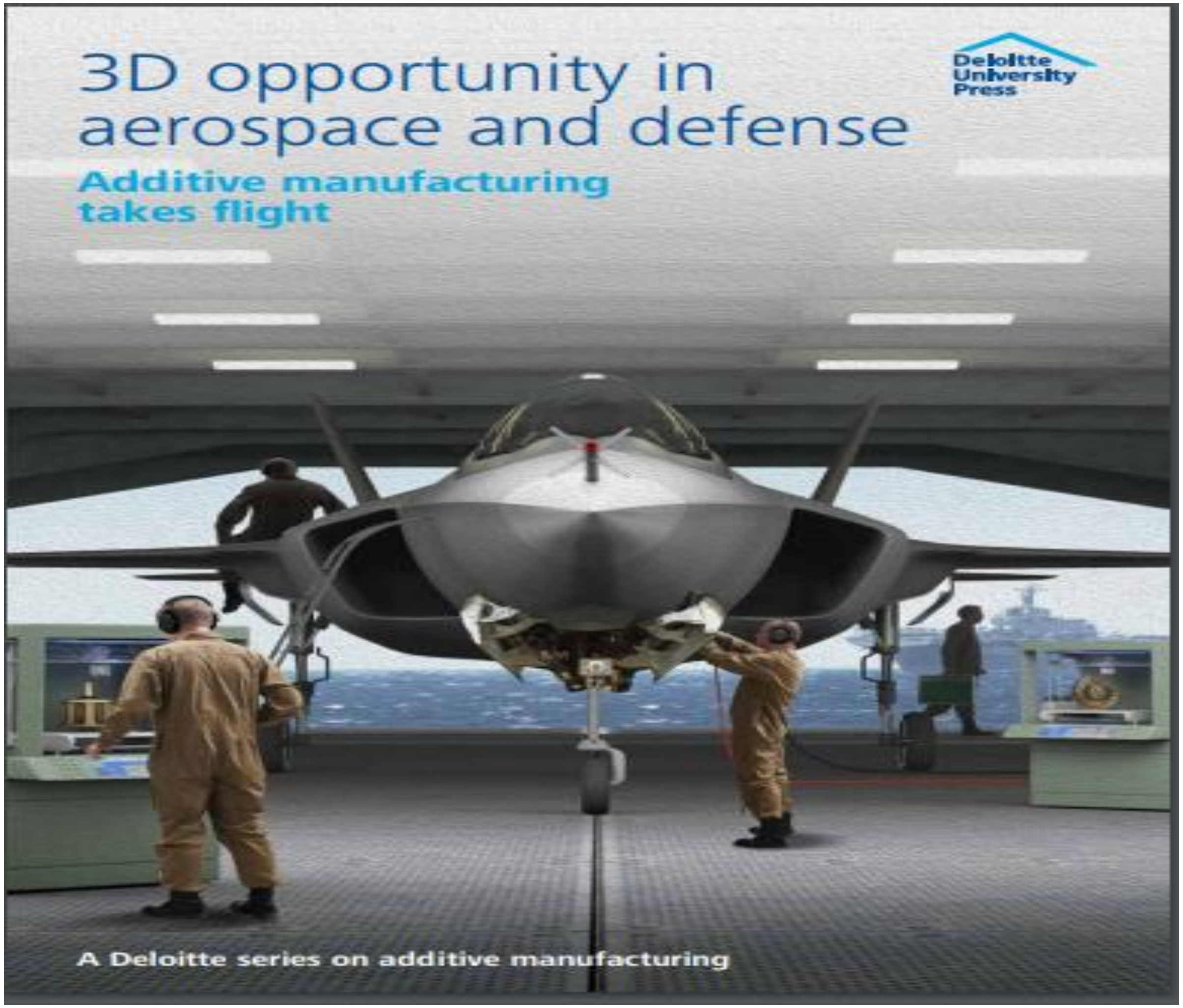


Advantages of Additive Manufacturing Technology

1. Design Complexity
2. Cost Saving
3. Environment-friendly
4. Lower Energy Consumption

Applications of Additive Manufacturing Technology

1. Aerospace Industry



Applications of Additive Manufacturing Technology

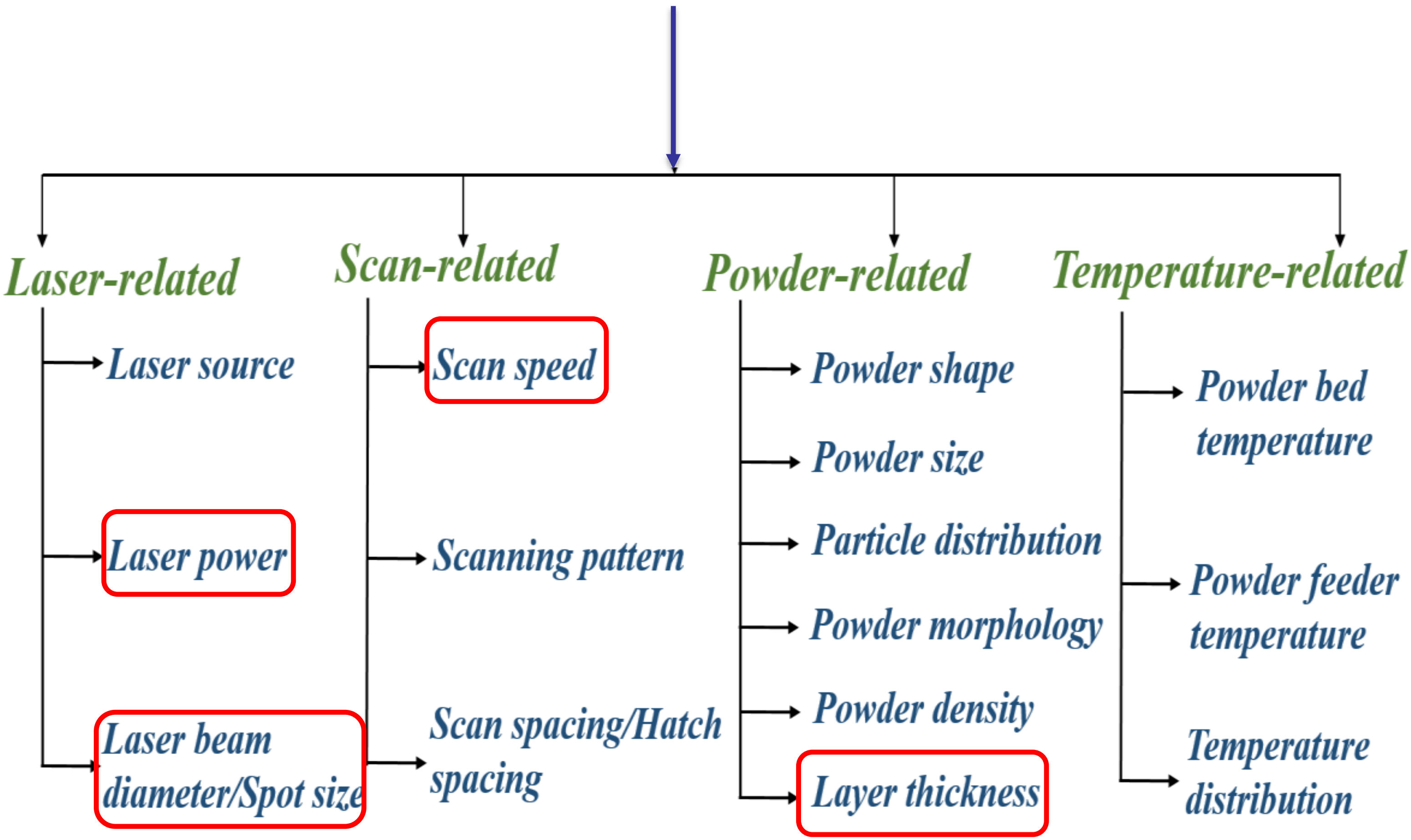
3. Biomedical Applications

Dental prosthesis

Hip stems fabricated

3-unit dental bridge

Selective Laser Melting Parameters



Types of titanium materials

α and near α	$\alpha+\beta$	β and near β
Al, Sn, Ga, Zr, C, O, N		
		V, Mo, Nb, Ta, Cr
Commercially pure Ti	Ti-5Al-2.5Fe	Ti-3Al-8V-6Cr-4Mo-4Zr
Ti-5Al-2.5Sn	Ti-5Al-2Mo-2Fe	Ti-4.5Al-3V-2Mo-2Fe
Ti-5Al-6Sn-2Zr-1Mo	Ti-5Al-3Mo-4Zr	Ti-5Al-2Sn-2Zr-4Mo-4Cr
Ti-6Al-2Sn-4Zr-2Mo	Ti-5Al-2.5Fe	Ti-6Al-6Fe-3Al
Ti-8Al-1Mo-1V	Ti-6Al-7Nb	Ti-10V-2Fe-3Al
	Ti-6Al-4V	Ti-13V-11Cr-3Al
	Ti-6Al-6V-2Sn	Ti-15V-3Cr-3Al-3Sn
	Ti-6Al-2Sn-4Zr-6Mo	Ti-35V-15Cr
		Ti-8Mo-8V-2Fe-3Sn
		Ti-11.5Mo-6Zr-4.5Sn
		Ti-30Mo, Ti-40Mo
		Ti-13Nb-13Zr
		Ti-25Pd-5Cr
		Ti-20Cr-0.2Sn
		Ti-30Ta

Objective and The most important issues for Ti alloys

1. Study the effect of SLM parameters on mechanical properties such as hardness and tensile test of new grades of Ti alloy.

❖ Ti-6Al-4V (α+β)

✓ Ti-13Nb-13Zr (β)

✓ Ti-30Ta (β)

The mechanical properties of some natural and biomaterials

Material	*Elastic modulus ($GN\ m^{-2}$)*	*Tensile strength ($MN\ m^{-2}$)*	*Elongation (%)*	*Fracture toughness ($MN\ m^{-3/2}$)*	*Fatigue strength ($MN\ m^{-2}$)*
Austenitic stainless steel	200	200–1100	40	100	200–250
Cobalt–Chromium	230	450–1000	10–30	100	600
Ti–6Al–4V	105–110	750–1050	12	80	350–650
Alumina	365	–	<1	–	400
Hydroxyapatite	85	40–100	–	–	
Glass fiber	70	2000	2	1–4	
PMMA	2.8	55	8	–	20–30
Bone cement	2.3–3	1.5	1–2	400	
Polyethylene	1	20–30		1–4	16
Nylon 66	4.4	700	25		
Silicone rubber	6×10^{-3}	1.4			
Polycarbonate	2	60			
Bone (cortical)	7–25	50–150	–	2–12	
Bone (cancellous)	0.1–1.0	50–150		2–12	
Tooth enamel	13	240	–	–	
Tooth dentine	–	135		–	
Collagen, tendon, wet	2	100	10	–	

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In vitro wear rate and Co ion release of compositionally and structurally graded CoCrMo-Ti6Al4V structures

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Metallic biomaterials are extremely successful in restoring lost functions of human bone under high loads. However, metals are bioinert and have a considerably higher stiffness than natural bone which significantly reduces the implant's *in vivo* lifetime. For example, total hip replacement (THR) surgeries are being performed more on younger patients below the age of sixty, which expose the implant to greater mechanical stress over a longer period of time due to their active lifestyle. Short life of current THR implants, between 7 and 12 years, is generally due to the aseptic loosening of the implant, which occurs due to (i) mismatch of the Young's modulus between bone (10–30 GPa) and metallic implant materials (110 GPa for Ti and 248 GPa for CoCrMo alloy) leading to stress-shielding, (ii) poor interfacial bond between the host tissue and the implant due to bioinert surface, (iii) wear induced osteolysis and aseptic loosening in metal-on-polymer implants, and (iv) absence of high recoverable strain (~ 2%) as well as hysteresis similar to natural bone. For these

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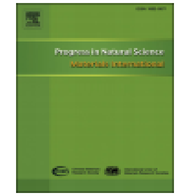

ORIGINAL RESEARCH

α′ Type Ti–Nb–Zr alloys with ultra-low Young's modulus and high strength

Qing Liu[a], Qingkun Meng[a], Shun Guo[a,b], Xinqing Zhao[a,*]

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[b]*Institute for Advanced Materials, Jiangsu University, Zhenjiang 212013, China*

Abstract α′ phase based Ti–Nb–Zr alloys with low Young's modulus and high strength were prepared, and their microstructure and mechanical properties were characterized. It was revealed that the lattice expansion by Nb and Zr addition as well as the presence of a few of α″ martensite might be responsible for the low modulus achieved. Ti–15Nb–9Zr alloy, with ultralow modulus of 39 GPa and high strength of 850 MPa, could be a potential candidate for biomedical applications.

Objective and The most important issues for Ti alloys

2. Study the effect of heat treatment on mechanical properties such as hardness and tensile test.

SLM is characterized by high temperature gradients, which results in the build-up of thermal stresses, and a rapid solidification, which gives rise to the occurrence of segregation phenomena and the presence of non-equilibrium phases.

Mechanical properties of these SLM parts are a high yield stress (about 1 GPa), a high ultimate tensile strength but a relatively low ductility (less than 10%).

Objective and The most important issues for Ti alloys

3. Investigate the SLM of Ti alloy - hydroxyapatite (HAp) composites

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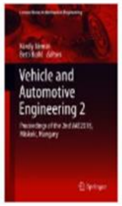

Vehicle and Automotive Engineering
VAE 2018: Vehicle and Automotive Engineering 2 pp 709-718 | Cite as

Dissimilar Resistance Spot Welding of Ferrite-Martensite Dual Phase Steel/Low Carbon Steel: Phase Transformations and Mechanical Properties

Authors | Authors and affiliations

Hassanen Jaber, Tunde Kovacs

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July 8-12, 2018
Budapest, Hungary

FEMS 30 — Federation of European Materials Societies 1987-2017
MAGYAR ANYAGTUDOMÁNYI EGYESÜLET

16 January, 2018

Dear Hassanen Jaber,

On behalf of the Organizing Committee, we are pleased to inform you that your abstract (Preparation and Synthesis of Hydroxyapatite Bio-Ceramic From Hungarian Bio-Waste by Thermal Heat Treatment) has been **accepted for oral presentation** at the FEMS Junior EUROMAT 2018 conference to be held between 08-12 July, 2018 in Budapest, Hungary.

Activities: Publications

THE EFFECT OF NANO-QUENCHING MEDIA ON THE TENSILE PROPERTIES AND MICROSTRUCTURE OF MEDIUM CARBON STEEL

HASSANEN JABER[1,2] AND TUNDE KOVACS[3]

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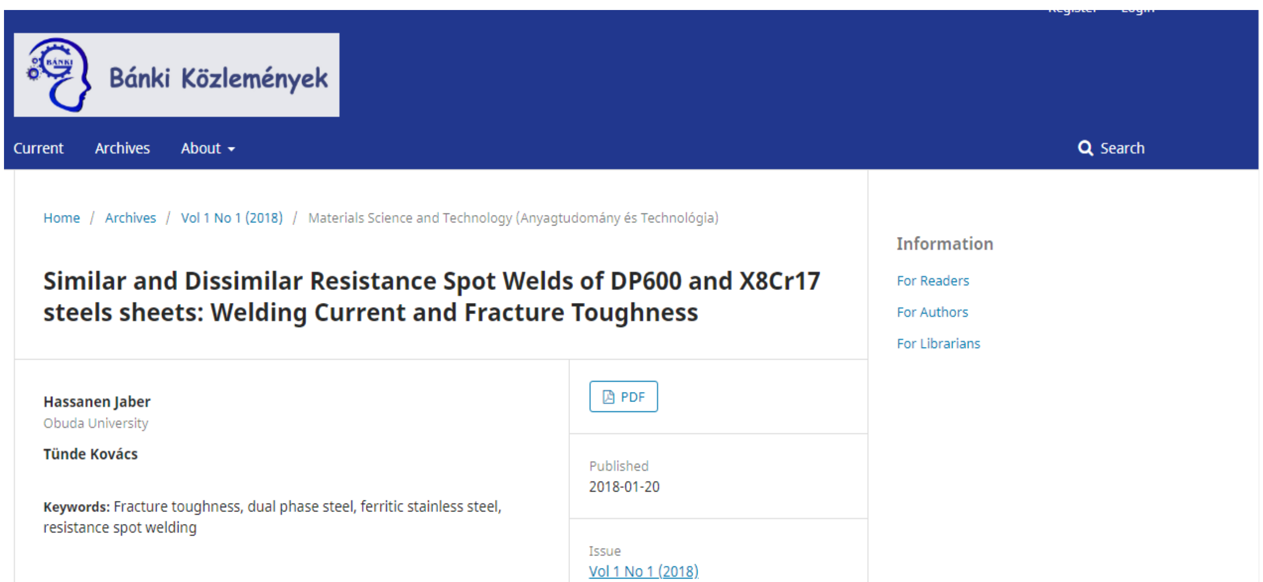
[2]Engineering College, University of Thi-Qar, Nasiriyah, Iraq
[3]Donát Bánki Faculty of Mechanical and Safety Engineering, Óbuda University, Hungary

Two different quenching media (water and Water/TiO2 Nano-fluid were used to compare the effect of thermal conductivity on the microstructure and mechanical properties of CK35 steel. The result has demonstrated that the microstructure for Nano-fluid (water base) quenching and tempering (NWQT) specimen is the mixture of tempered martensite and retained austenite with best mechanical properties, for water quenching and tempering (WQT) specimen is mostly tempered martensite. [1-4]

Keywords: CK35 steel, Thermal conductivity, microstructure, mechanical properties


Bánki Közlemények

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Similar and Dissimilar Resistance Spot Welds of DP600 and X8Cr17 steels sheets: Welding Current and Fracture Toughness

Hassanen Jaber
Obuda University
Tünde Kovács

Keywords: Fracture toughness, dual phase steel, ferritic stainless steel, resistance spot welding

PDF

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For Authors
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Activities: Participation in the Education of Undergraduate Students

1. Tensile Test
2. Impact Test
3. Hardness Test
4. Crystallline Structures
5. Imperfections in Crystalline Materials
6. Solidification of Metals and Alloys
7. Phase (equilibrium) Diagrams
8. Iron-Carbon Alloy System

Activities: Doctoral Subjects

Subjects	Lectures
Scanning Electron Microscope (SEM) Atomic Force Microscope (AFM) Fourier-Transform Infrared Spectrometers (FTIR)	Dr. Telegdi Judit Dr. Takacs Erzsebet
Finite element modeling of materials technologies	Dr. V. Gonda
Analysis of damage processes of structural materials	Dr Tunde KOVACS

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THANK YOU

Any questions