

# Preparation and Characterization of ODS Steels

Haroune Rachid BEN ZINE

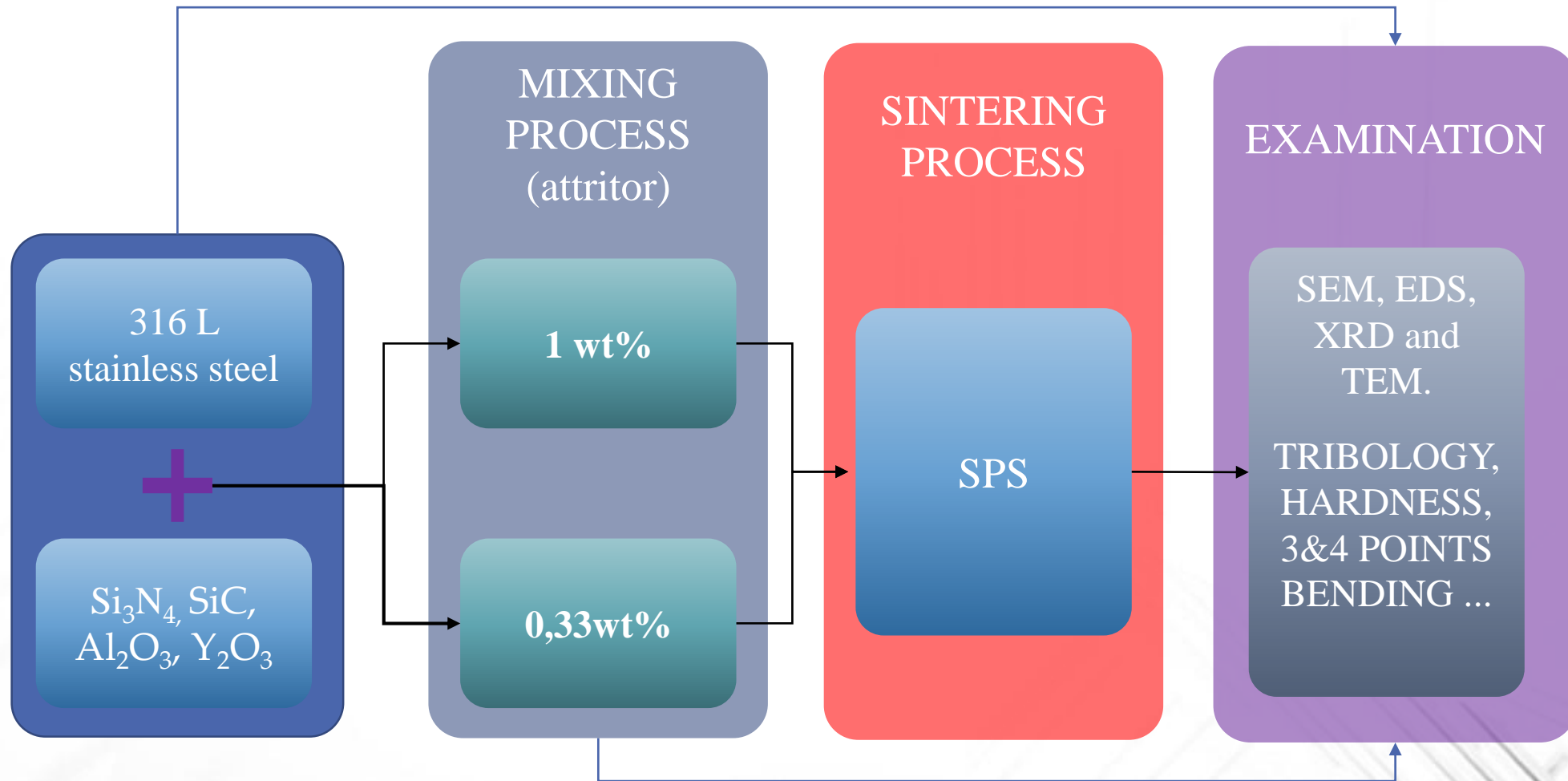
Under the supervision of:

Dr. Csaba Balázs  
Dr. Katalin Balázs

## Content:

- Flash from the previous semester
- Actual semester experimental results:
  - New results of 316L /  $\text{Si}_3\text{N}_4$  Composites
  - Making a prototype of a new additional part of sintering device
  - Preparation of the 316L / SiC samples for investigations
- Summary of the Actual semester
- Plans for the next semester

# Experimental steps:

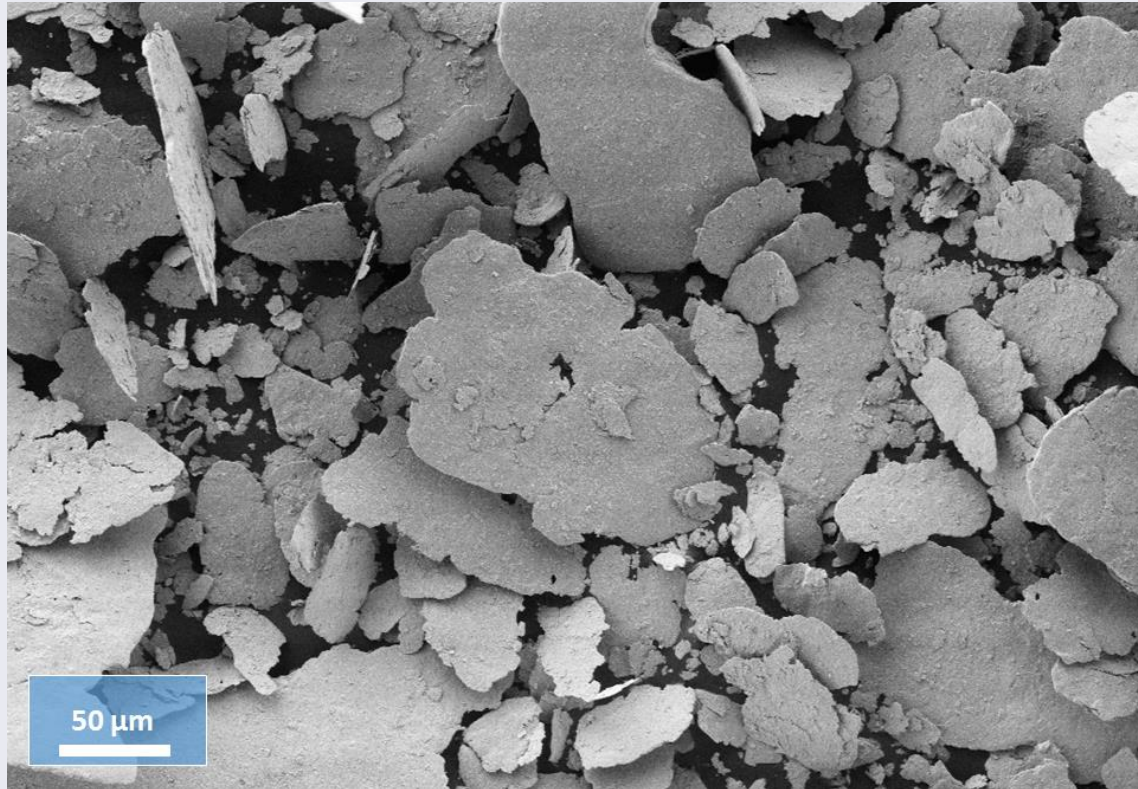




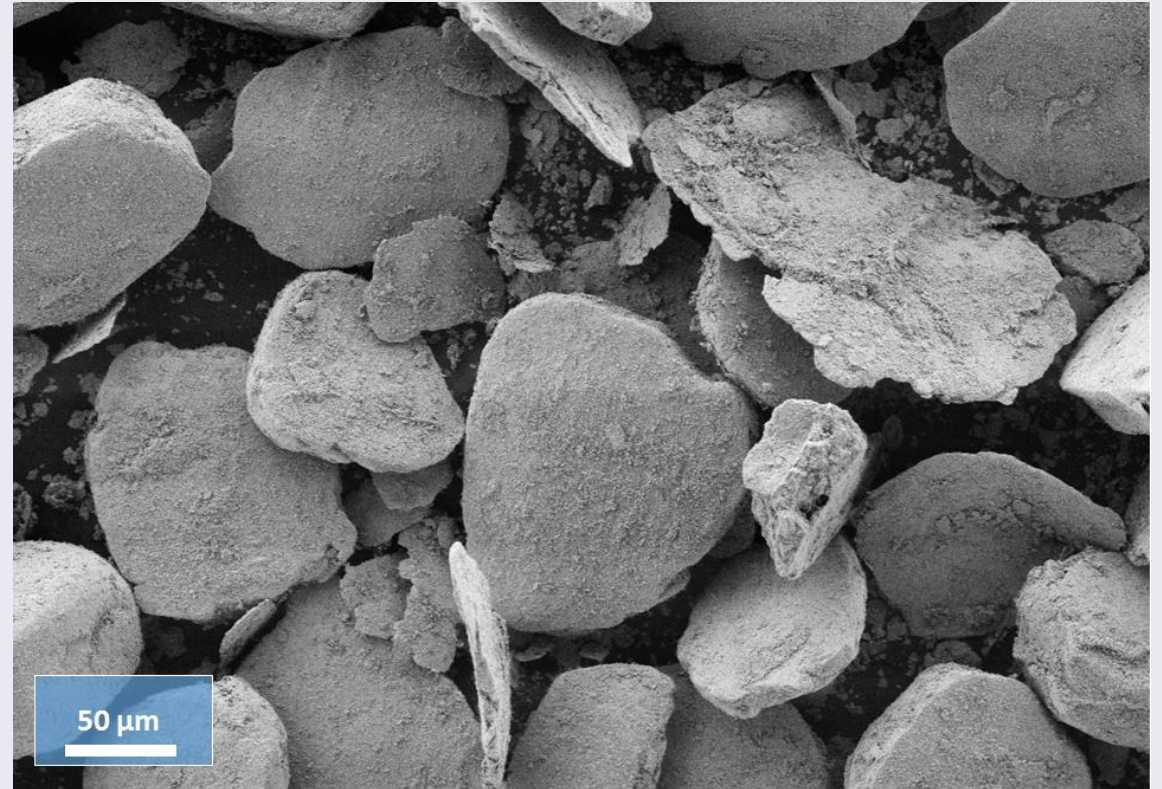
# 316L / Si<sub>3</sub>N<sub>4</sub> composite:

## Morphology after Milling Process

316L Hoganas + **0.33**wt% Si<sub>3</sub>N<sub>4</sub>



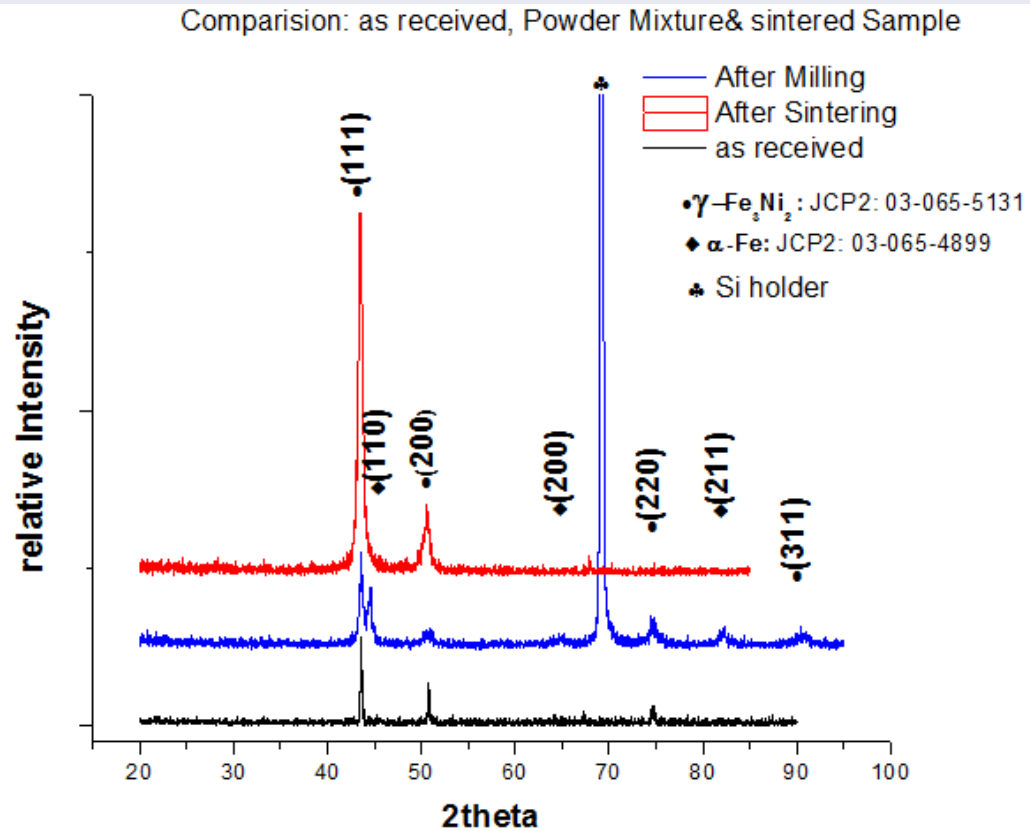
316L Hoganas + **1** wt% Si<sub>3</sub>N<sub>4</sub>



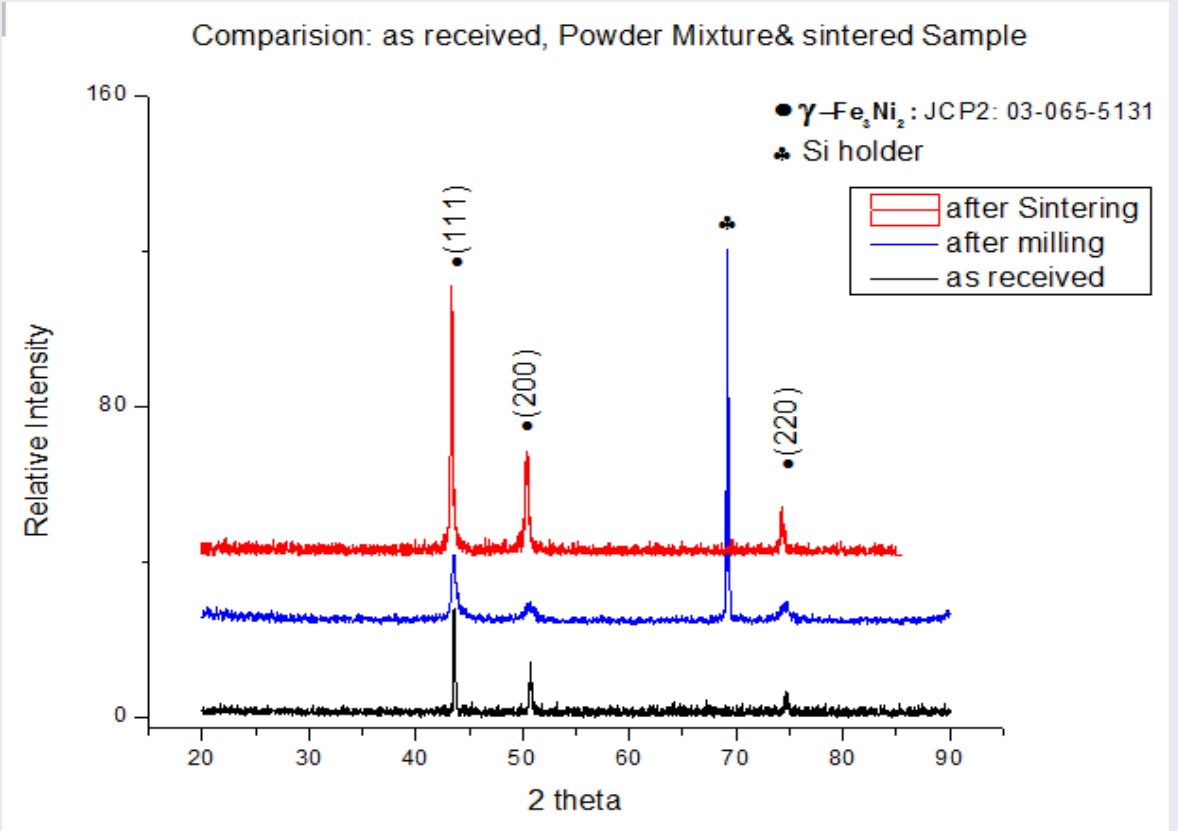
# 316L / Si<sub>3</sub>N<sub>4</sub> composite:

## XRD

316L Hoganas + **0.33**wt% Si<sub>3</sub>N<sub>4</sub>



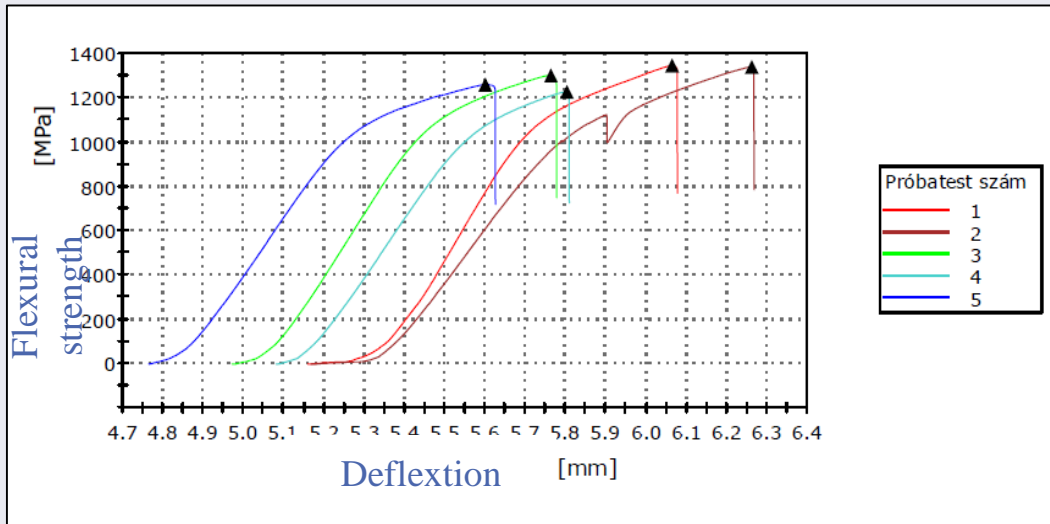
316L Hoganas + **1** wt% Si<sub>3</sub>N<sub>4</sub>



# 316L / Si<sub>3</sub>N<sub>4</sub> composite:

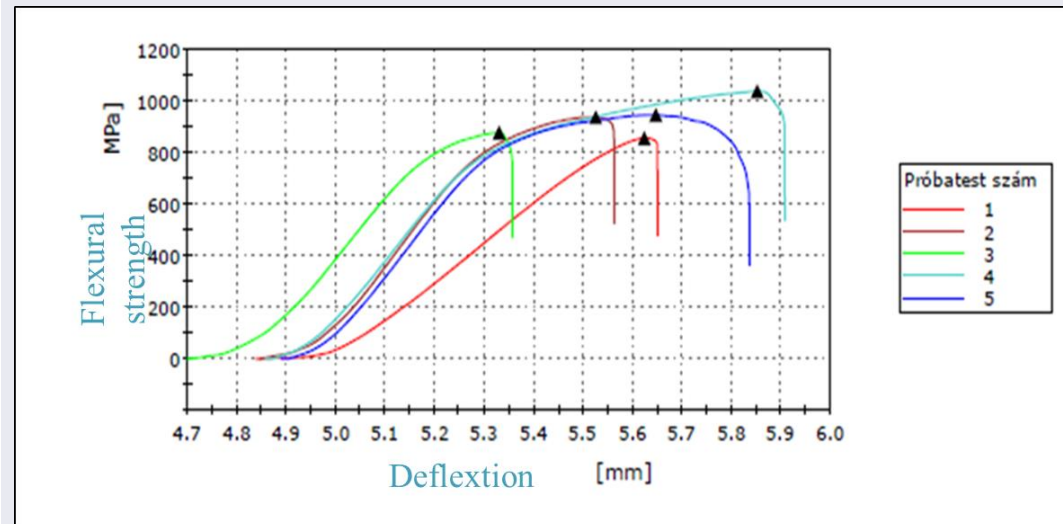
## Three points Bending Test

316L Hognas +0.33wt% Si3N4



Test Number	Sample identifier	Flexural strength	Maximum load
1	0.33wtSi3N 1.1	1345	2225,2
2	0.33wtSi3N 1.2	1339	2645.1
3	0.33wtSi3N 1.3	1301	2601.8
4	0.33wtSi3N 1.4	1227	2699.5
5	0.33wtSi3N 3.1	1259	2963.5

316L Hognas +1 wt% Si3N4



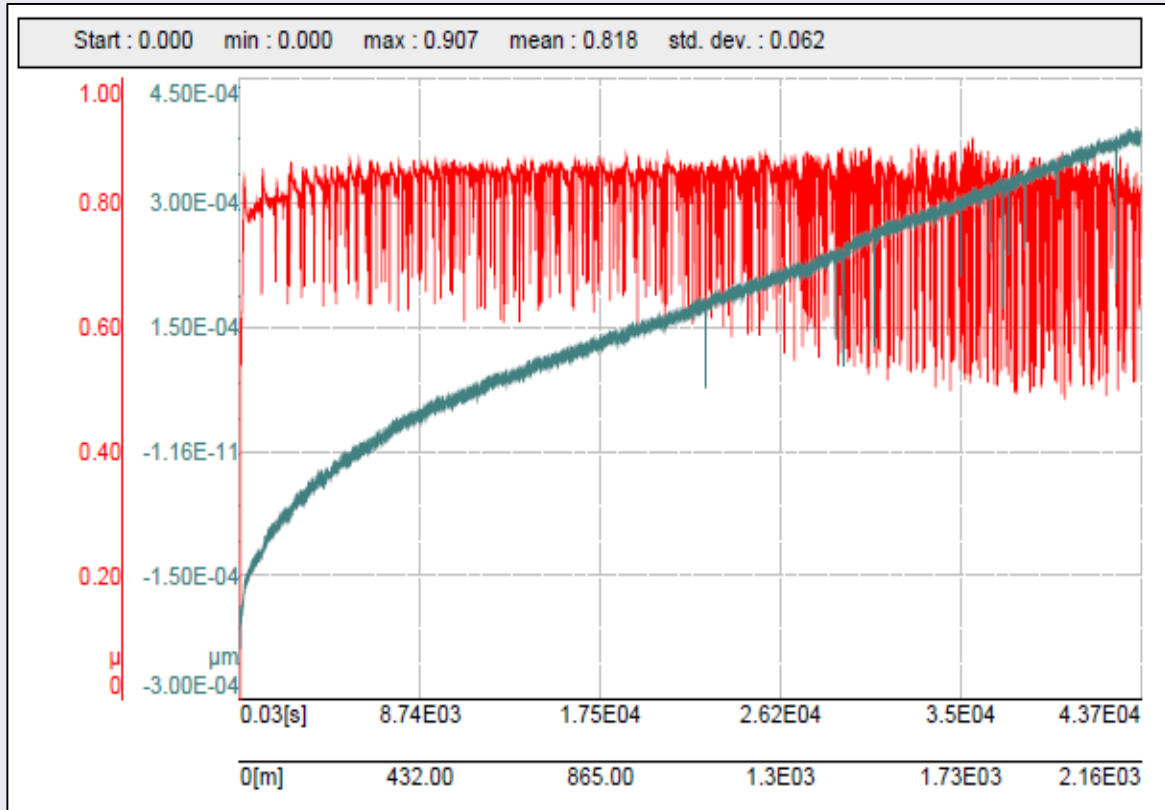
Test Number	Sample identifier	Flexural strength	Maximum load
1	1wtSi3N4-1	857	4202,7
2	1wtSi3N4-4	938	2022,9
3	1wtSi3N4-5	878	2087,5
4	1wtSi3N4-6	1039	2430,1
5	1wtSi3N4-7	947	2168,4



# 316L / Si<sub>3</sub>N<sub>4</sub> composite:

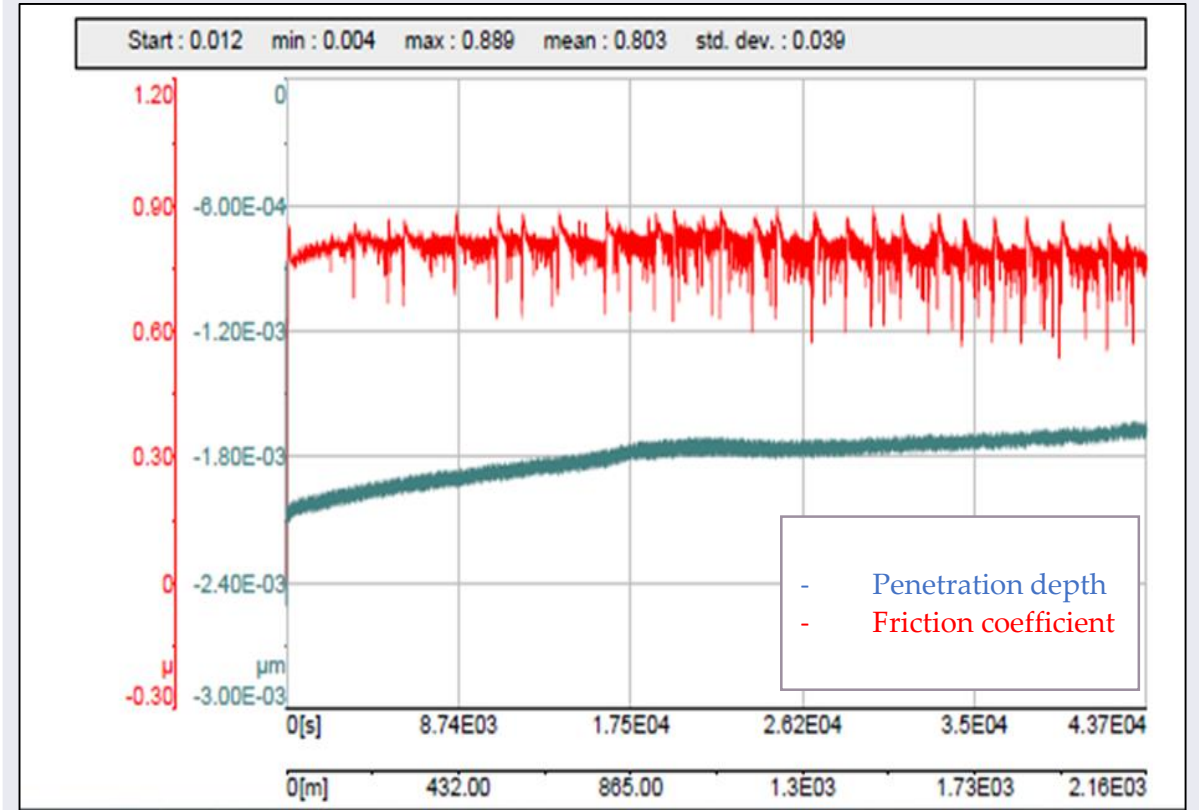
## Tribology

316L Hognas + **0.33**wt% Si<sub>3</sub>N<sub>4</sub>



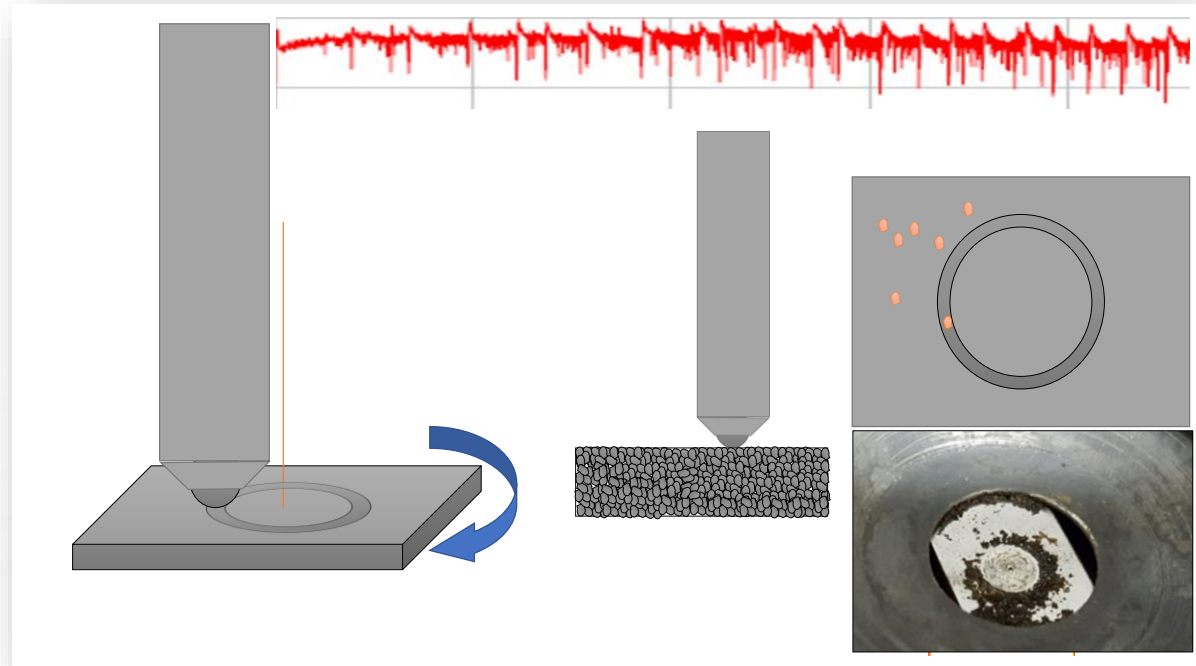
12 hours long tribology test results

316L Hognas + **1** wt% Si<sub>3</sub>N<sub>4</sub>

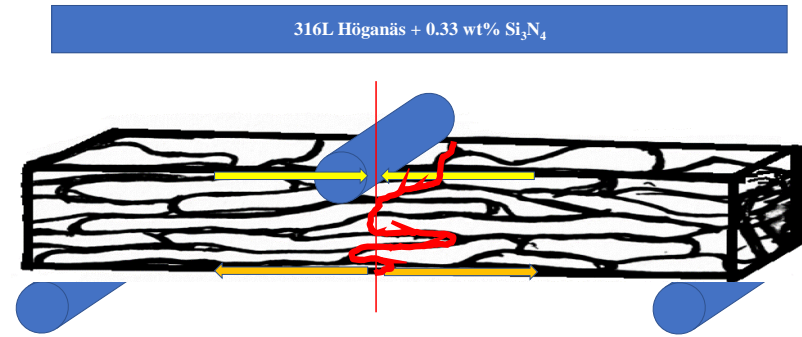


12 hours long tribology test results

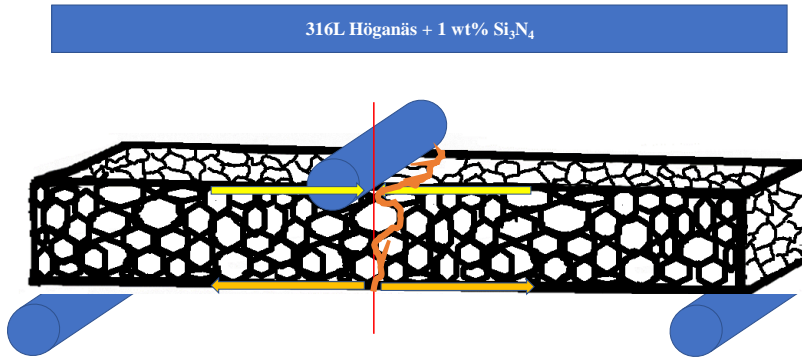
# Modell of fracture in 316L / Si<sub>3</sub>N<sub>4</sub> composite:



Tribology



316L Höganäs + 0.33 wt% Si<sub>3</sub>N<sub>4</sub>

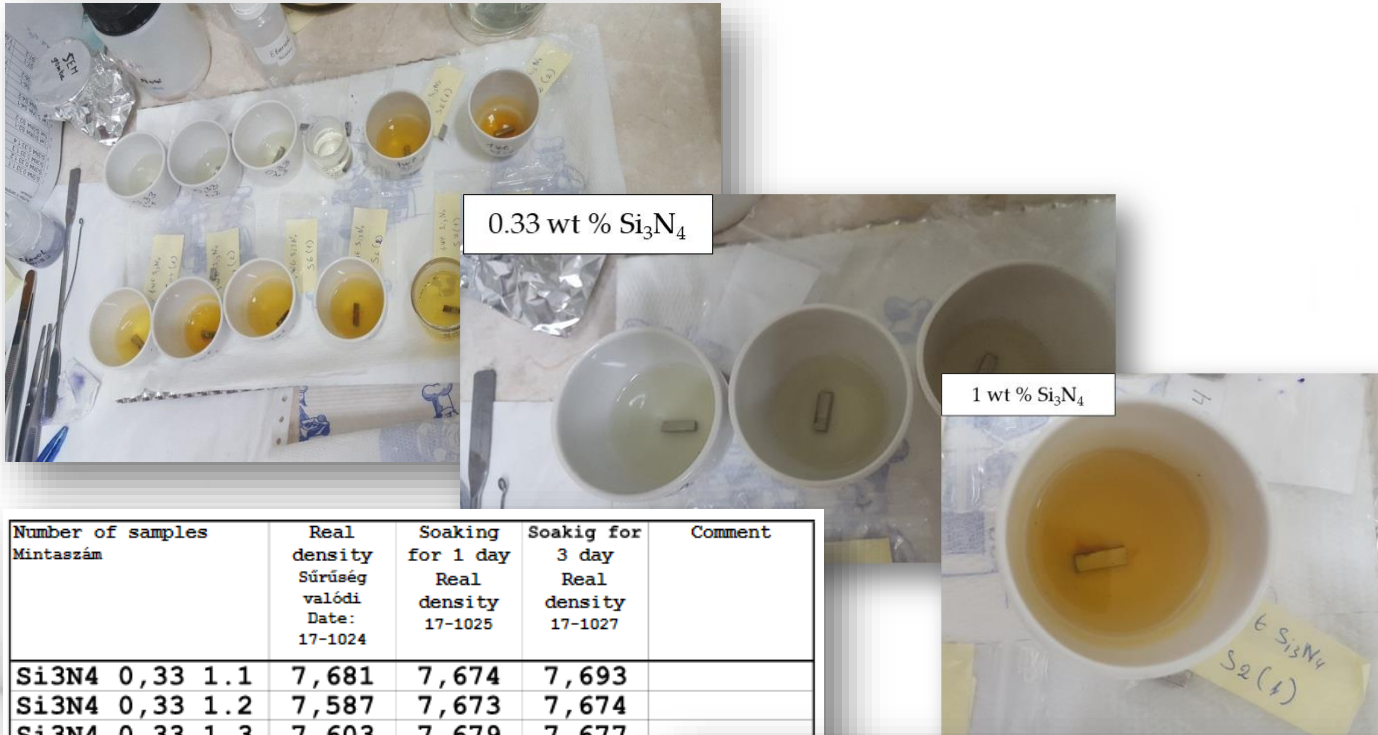


316L Höganäs + 1 wt% Si<sub>3</sub>N<sub>4</sub>

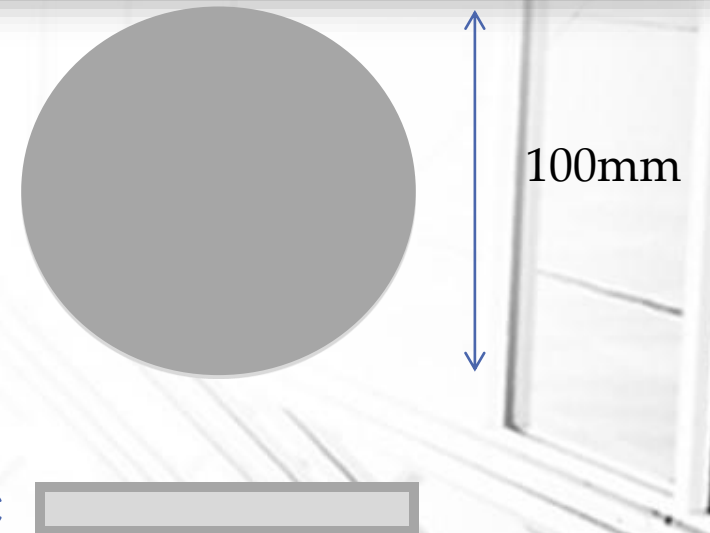
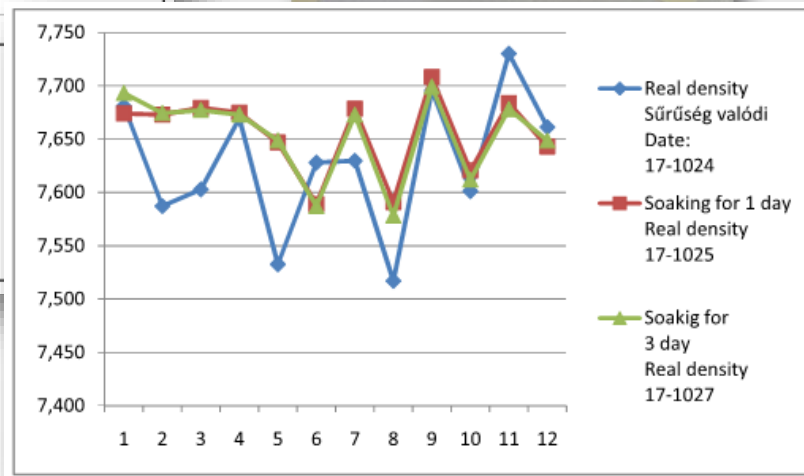
Three Points bending Test



# Density Measurements:

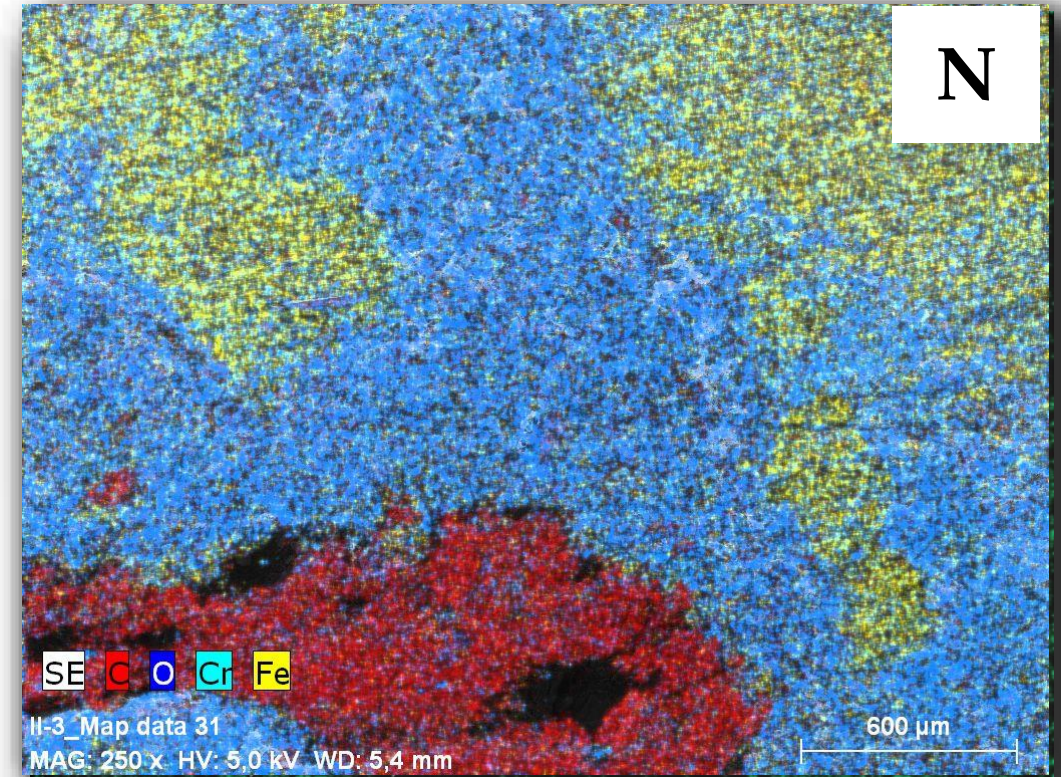
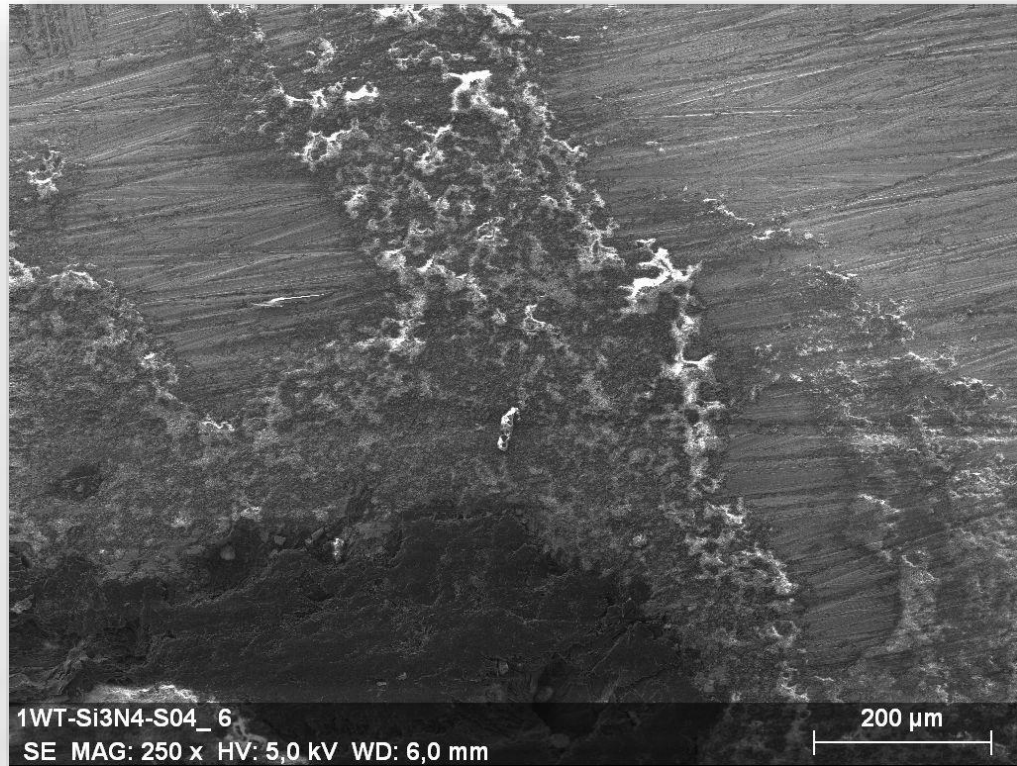


Number of samples Mintaszám	Real density Sűrűség valódi Date: 17-1024	Soaking for 1 day Real density 17-1025	Soakig for 3 day Real density 17-1027	Comment
Si3N4 0,33 1.1	7,681	7,674	7,693	
Si3N4 0,33 1.2	7,587	7,673	7,674	
Si3N4 0,33 1.3	7,603	7,679	7,677	
Si3N4 0,33 1.4	7,669	7,675	7,673	
1wt Si3N4 S2-1	7,533	7,647	7,649	
1wt Si3N4 S2-2	7,628	7,589	7,587	
1wt Si3N4 S4-1	7,630	7,679	7,673	
1wt Si3N4 S4-2	7,517	7,591	7,578	
1wt Si3N4 S6-1	7,695	7,708	7,699	
1wt Si3N4 S6-2	7,601	7,620	7,612	
1wt Si3N4 S7-1	7,730	7,684	7,678	
1wt Si3N4 S7-2	7,661	7,643	7,649	





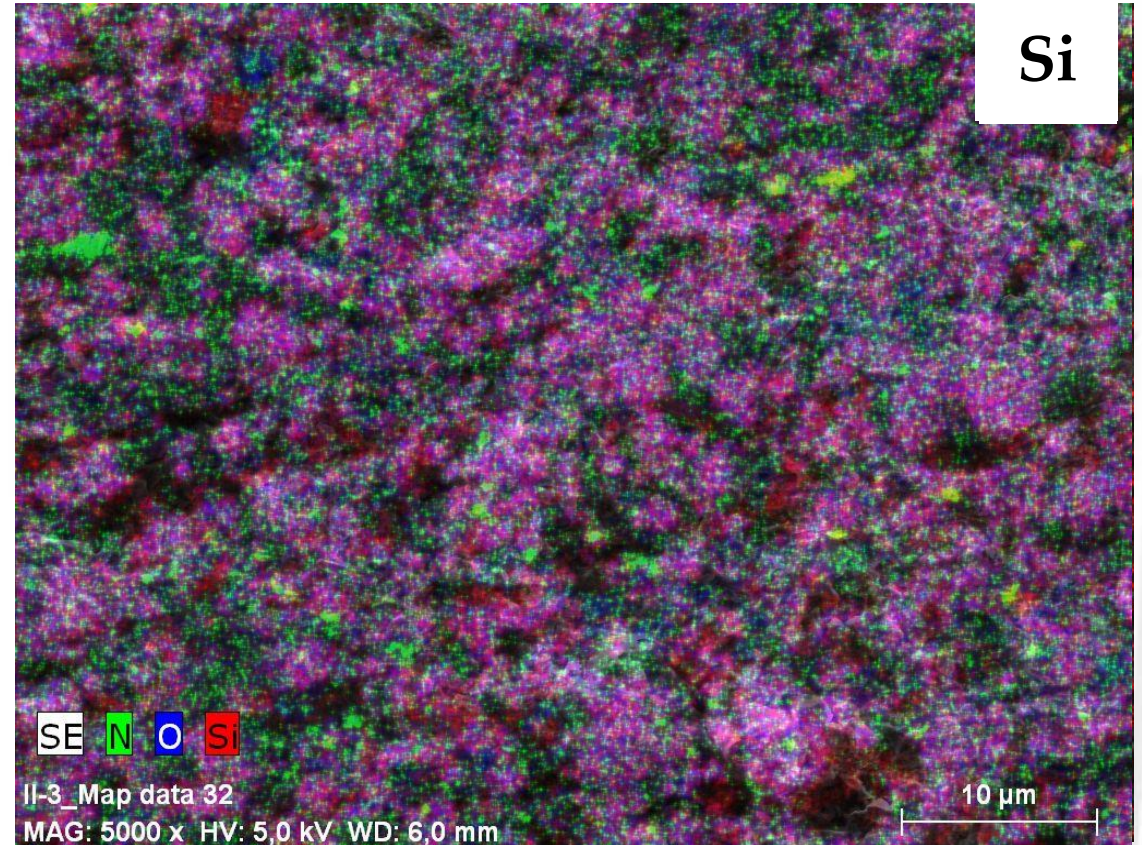
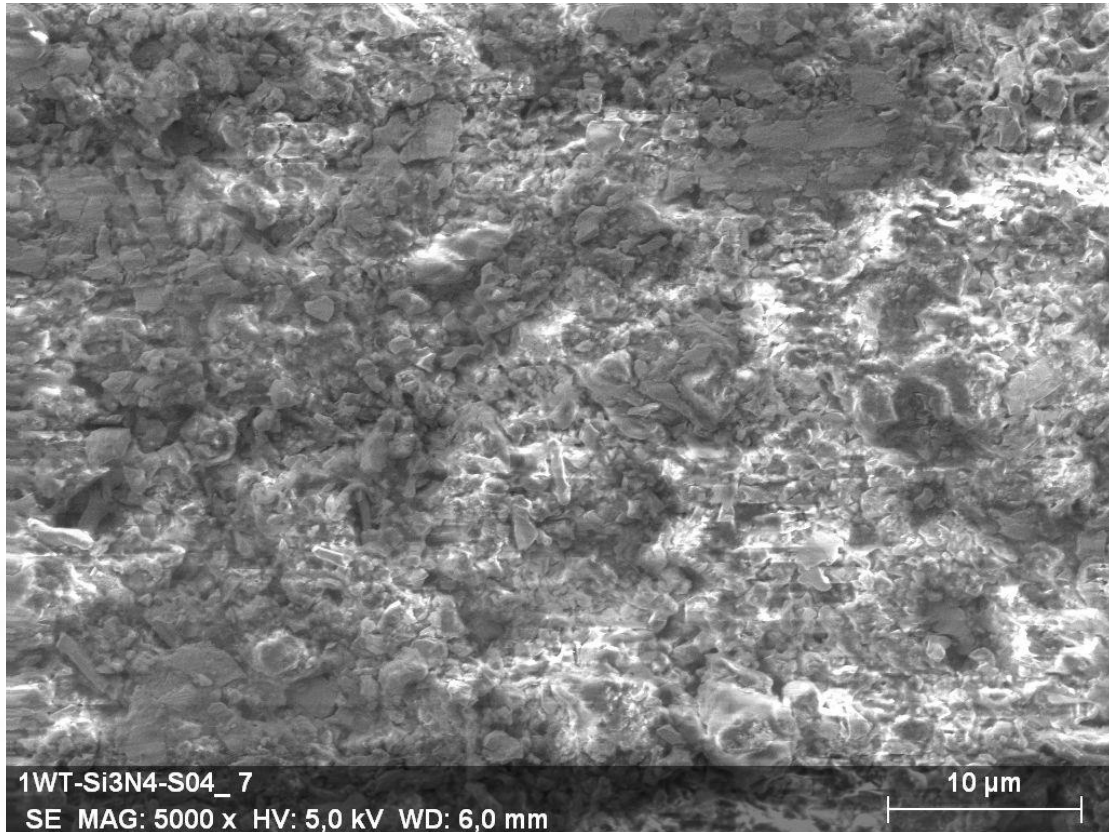
# Elemental mapping of the corroded surfaces(1wt%Si<sub>3</sub>N<sub>4</sub>):





# Elemental mapping of the corroded surfaces (1wt%Si<sub>3</sub>N<sub>4</sub>):

Elemental mapping at higher magnification





**Fabrication of a prototype  
additional part of sintering device**

**„idea that we developed”**

We are applying for the national patent





# Summary of the Actual semester

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- investigation of the 316L / Si<sub>3</sub>N<sub>4</sub> composites Corroded Samples by SEM and EDS
- Investigation of structural, mechanical, tribological properties of 316L based composites
- Developing a new idea in materials elaboration and applying for a patent
- Making a prototype of the new device for demonstration purposes
- H. R. Ben Zine, Á. Horváth, F. C. Sahin, Zs. Czigány, K. Balázsi, Cs. Balázsi, **Effect of ceramic addition on structural and mechanical properties of steel alloys**, 15th Conference & Exhibition of the European Ceramic Society, 2017. Július 7-13, Budapest, **poster**
- H, R. Ben Zine, Zs. Czigány, F. S. Cinar, Á. Horváth, K. Balázsi, C. Balázsi, **Si<sub>3</sub>N<sub>4</sub> dispersion strengthened 316L stainless steels: structural and mechanical properties**, International Conference - Deformation and Fracture in PM Materials, High Tatras, 2017. Okt.22-25, **Oral presentation**
- 17<sup>th</sup>PhD Students Materials Science Day”2017. Dec 4, **study of si<sub>3</sub>n<sub>4</sub> addition effect on structural and mechanical properties of the 316l stainless steel, Oral presentation**
- **Publication:**

**Haroune R. Ben Zine**, Filiz Cinar Sahin, Zsolt E Horváth, Zsolt Czigány, Ákos Horváth, Katalin Balázsi, Csaba Balázsi, Effect of Si<sub>3</sub>N<sub>4</sub> addition on the morphological and structural properties of the 316L stainless steel for nuclear applications, **RESOLUTION AND DISCOVERY 2: Paper 55. 8 p. (2017)**

**Haroune R. Ben Zine**, A. Horváth, K. Balázsi, C. Balázsi, Submicron sized sintered ODS steels prepared by high efficient attritor milling and spark plasma sintering, **COURRIER DU SAVOIR 24: pp. 93-100. (2017)**



# Summary of the Actual semester

- Participating in Scindicàtor



# Plans for next Semester:

- Continuing the investigation of the 316L / SiC Composites
- Participate in Junior Euromat 2018 Conference, Budapest, Hungary
- Participate in E-MRS Conference in Strasbourg, France
- Participate in MMT Conference in Siófok, Hungary
- Submitting Two papers in Journals with IF
- Write and Defend my thesis “hopefully”



A close-up photograph of a hand in a dark suit sleeve giving a thumbs up gesture. The hand is the central focus, with the thumb pointing upwards. The background is dark and out of focus.

**THANK YOU FOR YOUR ATTENTION**