End of semester IV Presentation

Preparation and characterization of Oxide Dispersion Strengthened (ODS) steels.

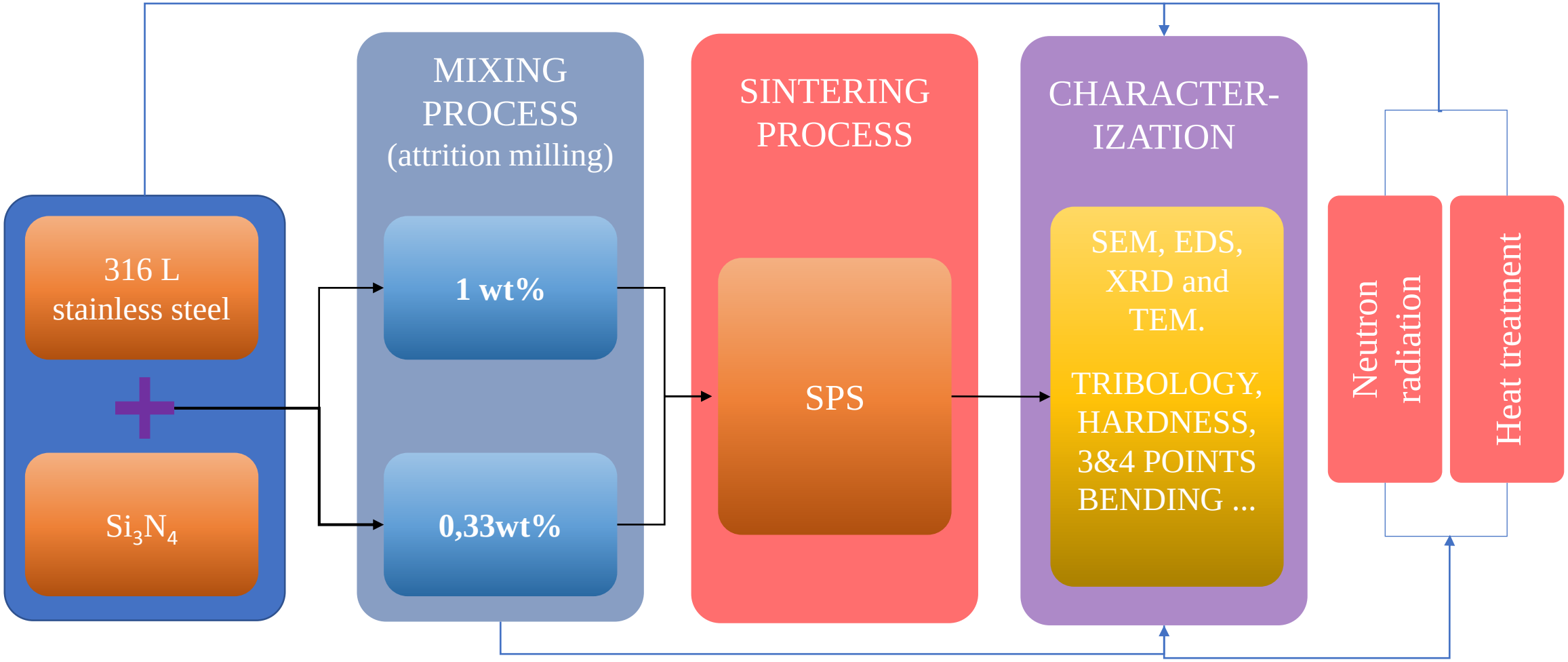
Presented by:
BEN ZINE Haroune Rachid

Under the supervision of:
Dr. Balàzsi Csaba
Dr. Balàzsi Katalin

Content:

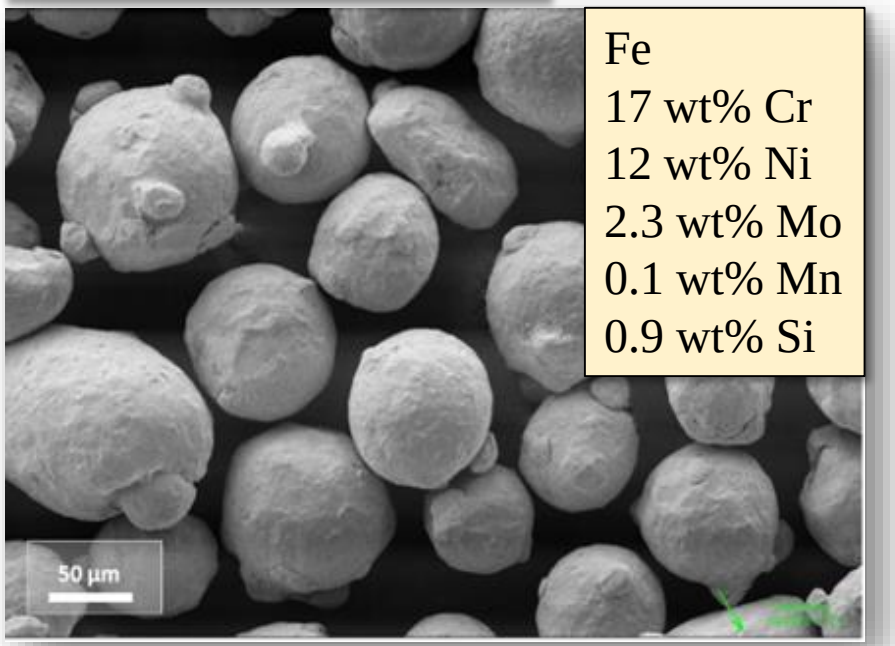
- Experiments work Plan
- First Experimental results:
    - 316L Höganäs+ 0.33wt% Si3N4
    - 316L Höganäs+ 1wt% Si3N4
- Results Comparison
- Conclusion
- Results of the actual semester
- Future work plans

Experiments Work Plan:



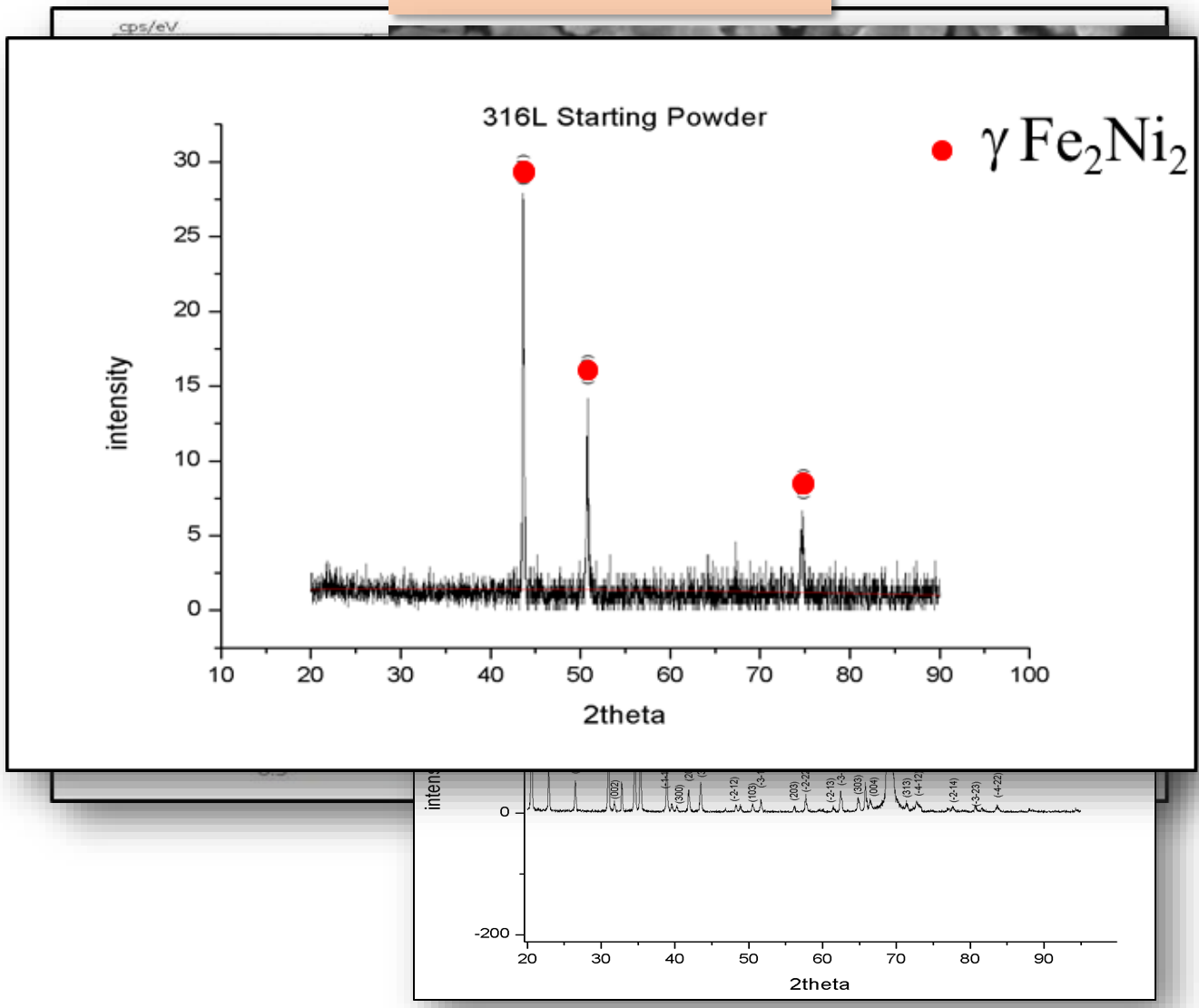
Structure of based materials

316L Höganäs (reference)



Fe
17 wt% Cr
12 wt% Ni
2.3 wt% Mo
0.1 wt% Mn
0.9 wt% Si

UBE Si_3N_4 (addition)

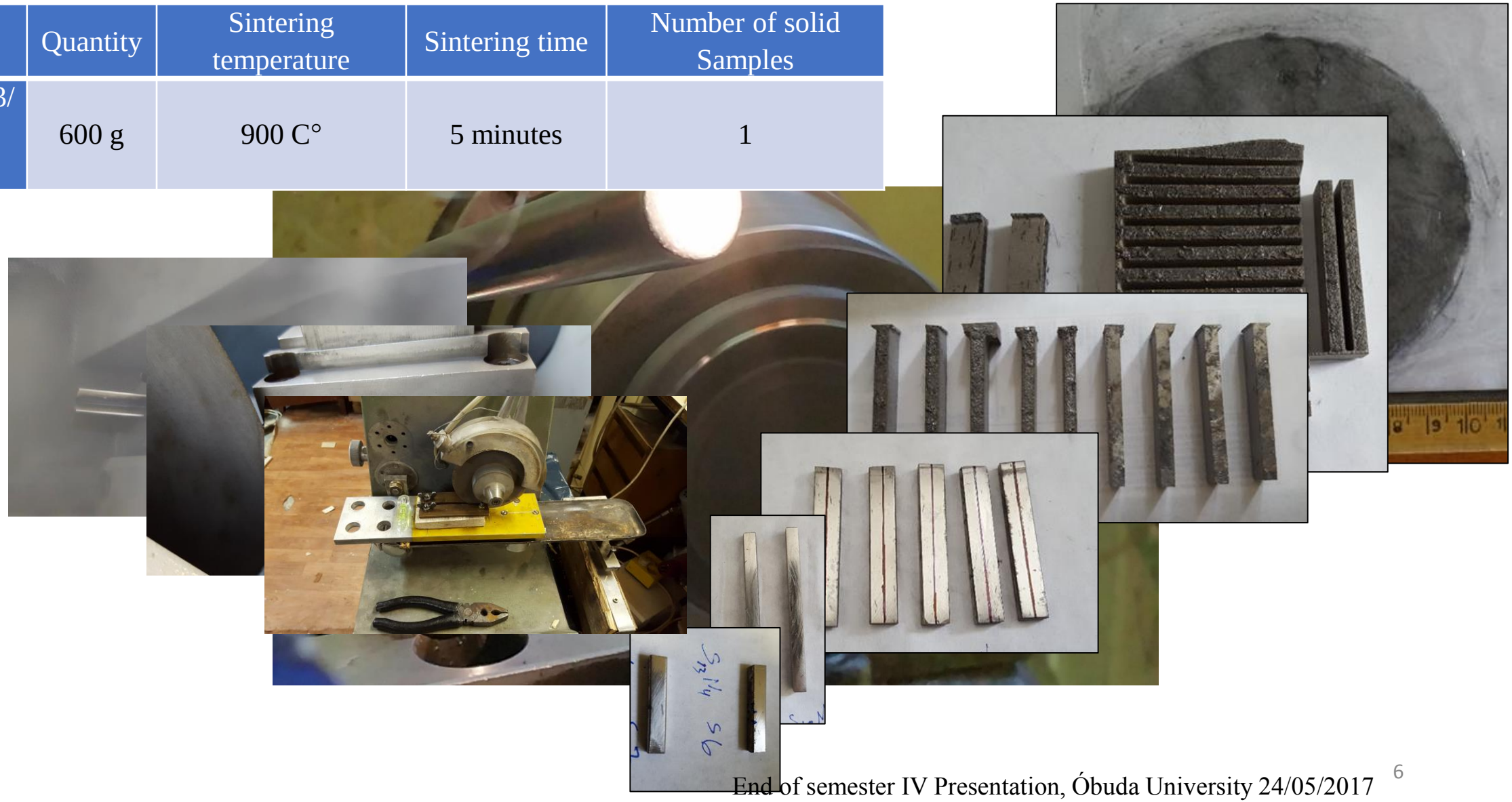


High efficient attrition milling:

Material	Mass	Grinding material		Container	Milling type		Milling Speed	Milling time	Drying conditions	
Höganäs 316 L (SS)	**300**g	Stainless steel Balls		Big	Wet	Quantity	**603** rpm	**5** hours	Spinning speed	Drying temperature
Si3N4	**3**g	Diameter	Quantity	**1400** ml	**ethanol**	**300** ml			**100** rpm	**75** C°
		3 mm	2.9 kg							

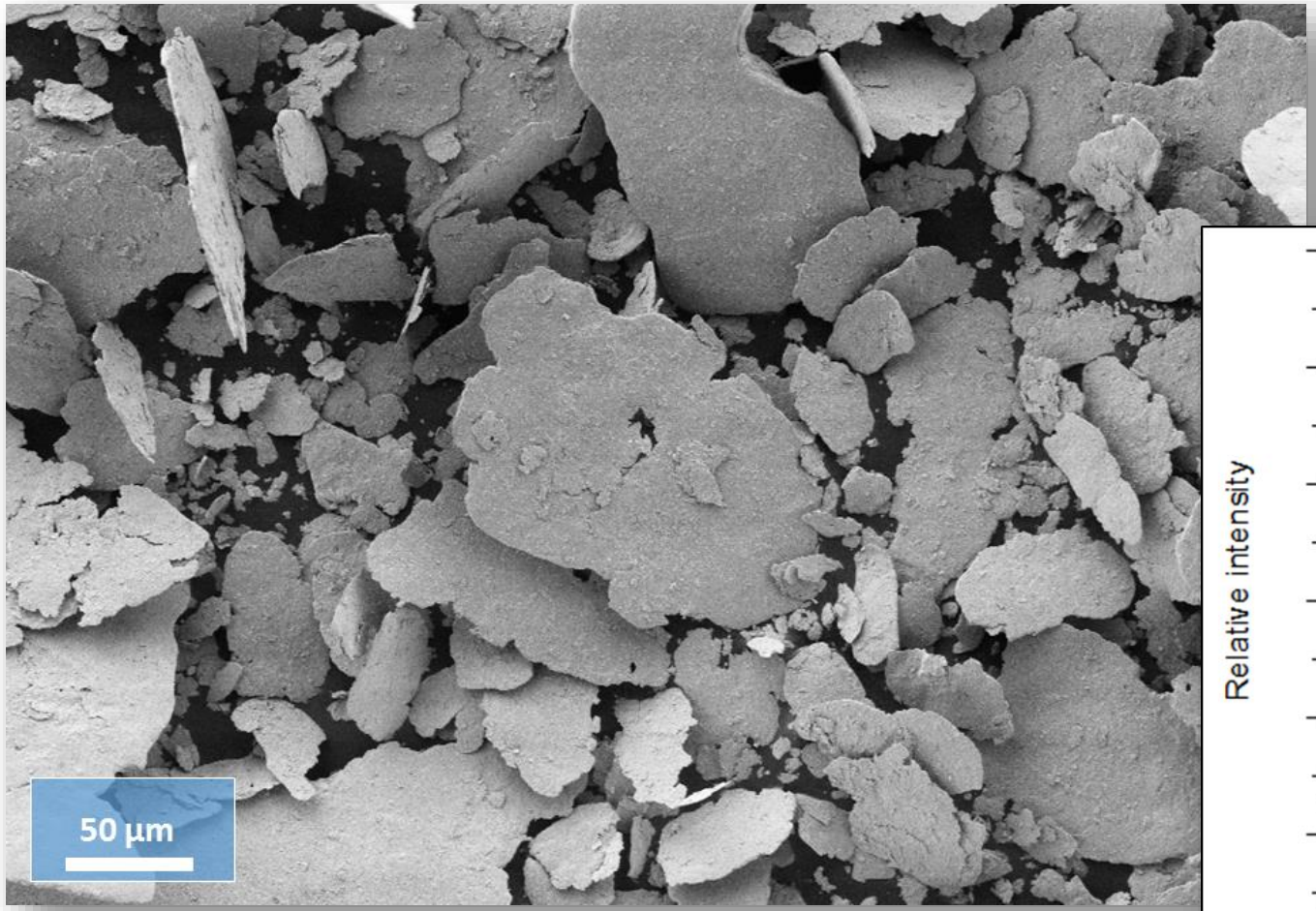
Sintering Process: Spark Plasma Sintering (SPS):

Alloy	Quantity	Sintering temperature	Sintering time	Number of solid Samples
316L+0.33/ 1wt% Si3N4	600 g	900 C°	5 minutes	1



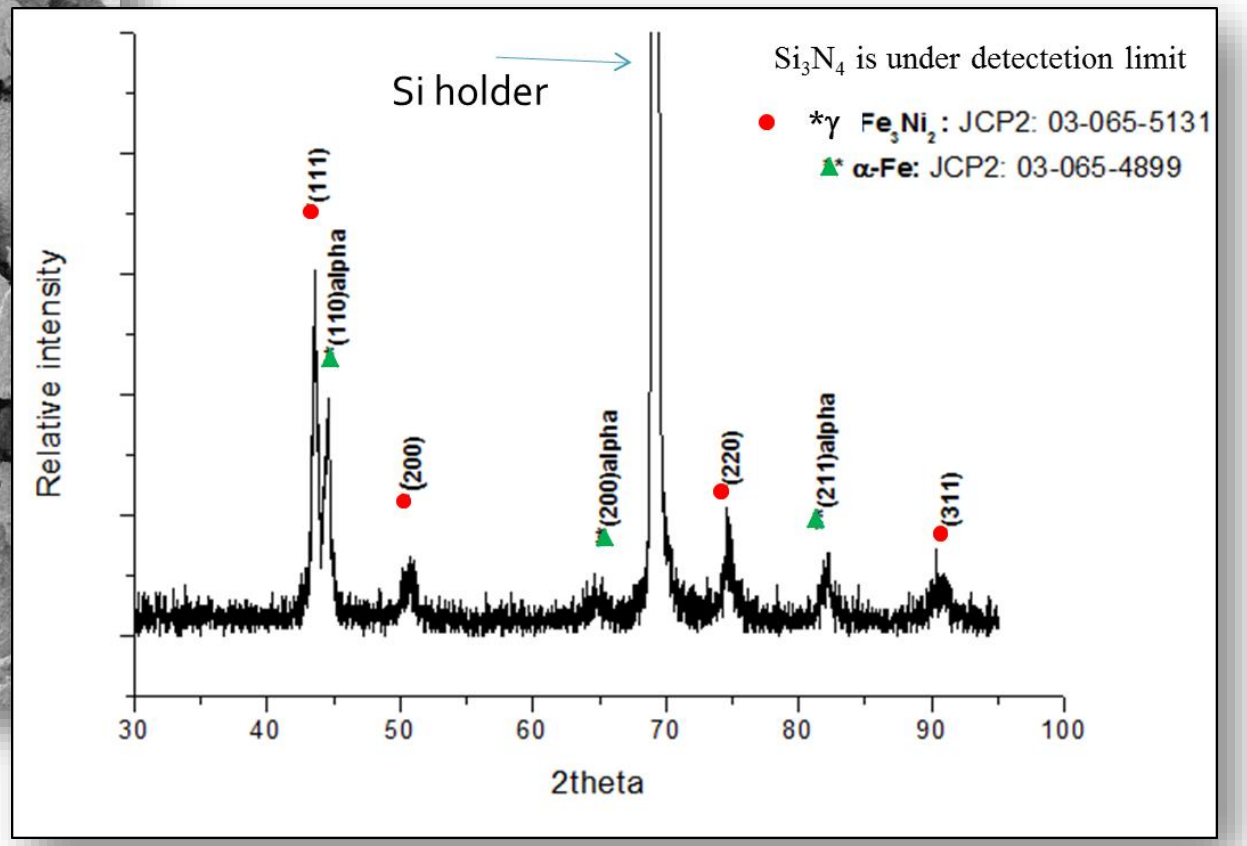
316L Höganäs + 0.33 wt% Si_3N_4

Structure of milled 316L / 0.33 wt% Si_3N_4

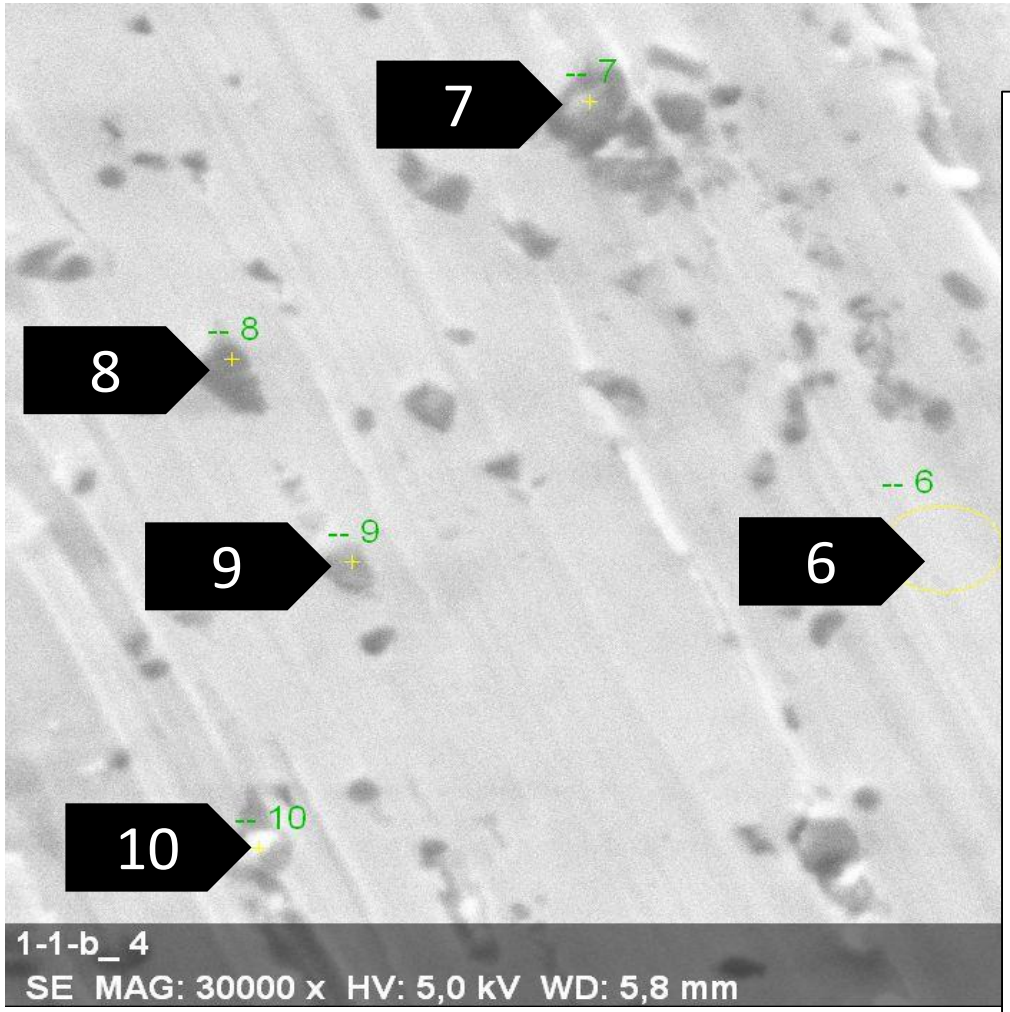


SEM image of milled powder with lamellar grains

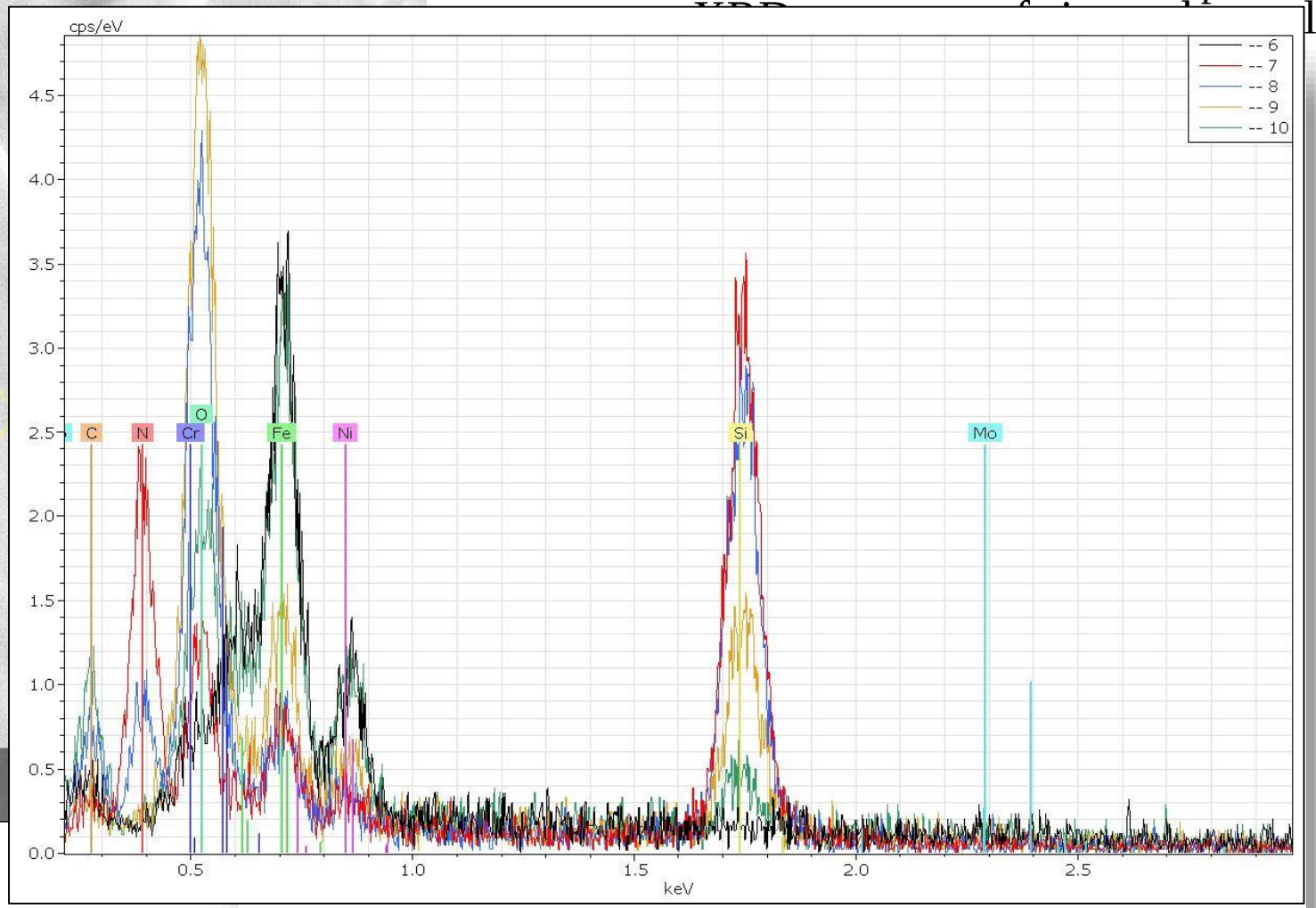
XRD spectrum of milled powder



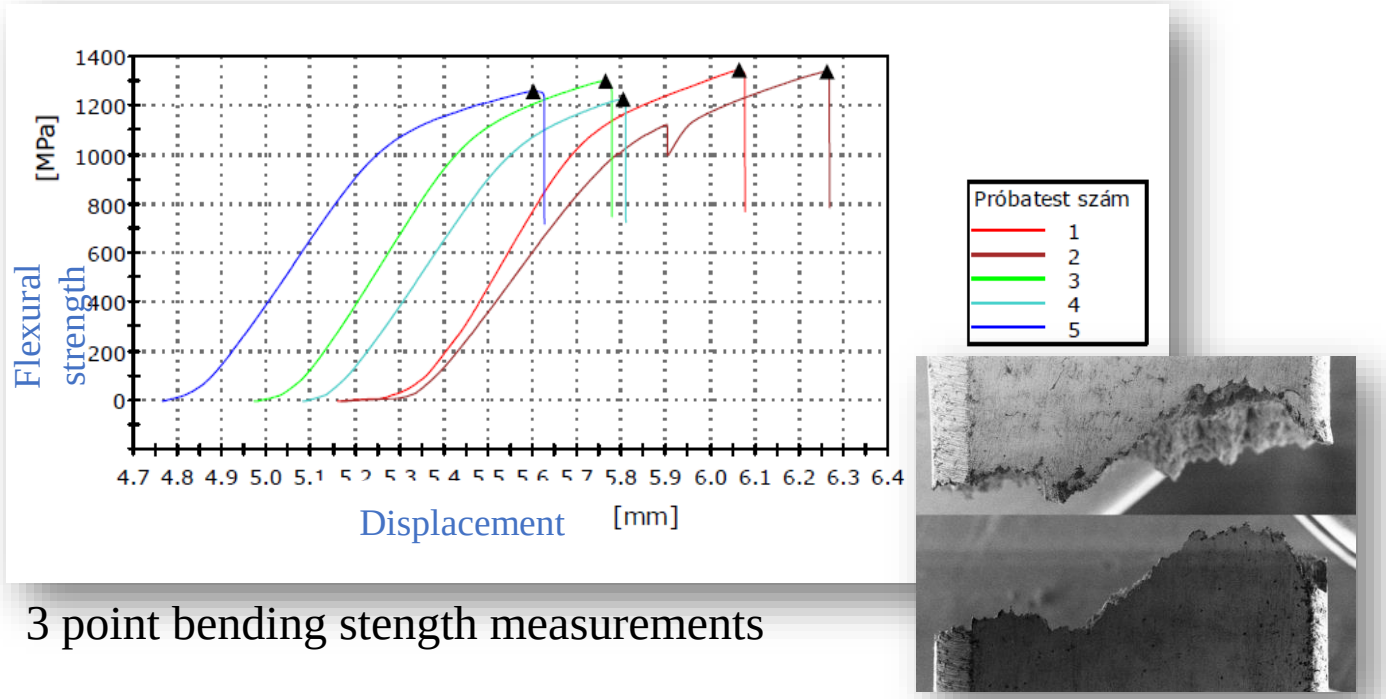
Structure of sintered 316L / 0.33 wt% Si_3N_4



EDS spectra of the 316L+ 0.33 wt % Si3N4 Sintered Sample



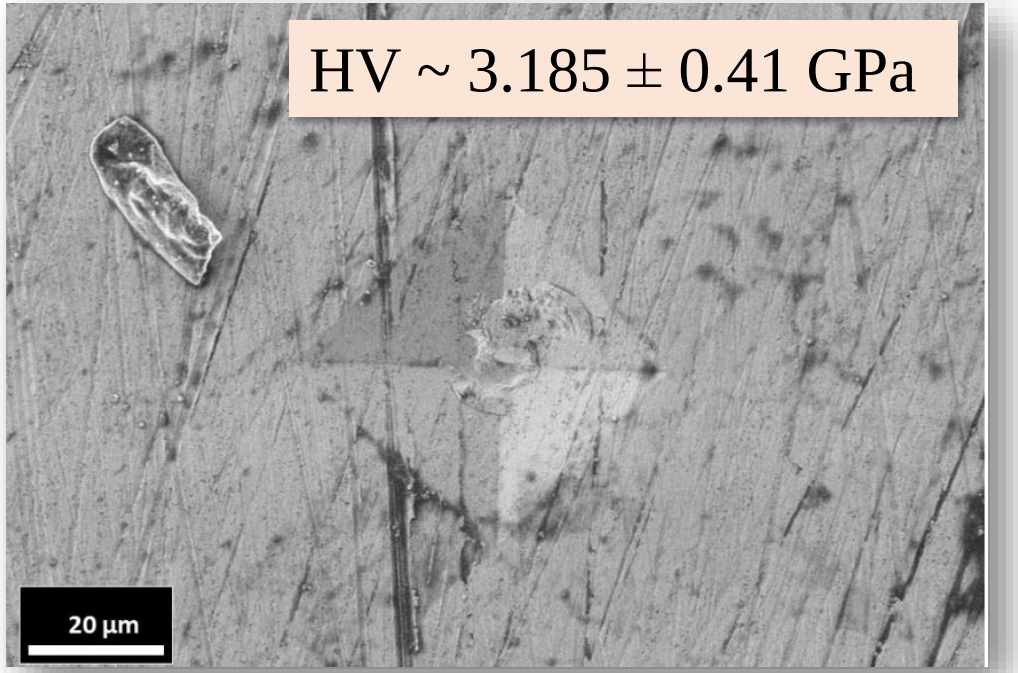
Properties of sintered 316L / 0.33 wt% Si_3N_4



3 point bending stength measurements

3p bending strength ~ 1472 MPa (*5% error)

SEM image of indentation

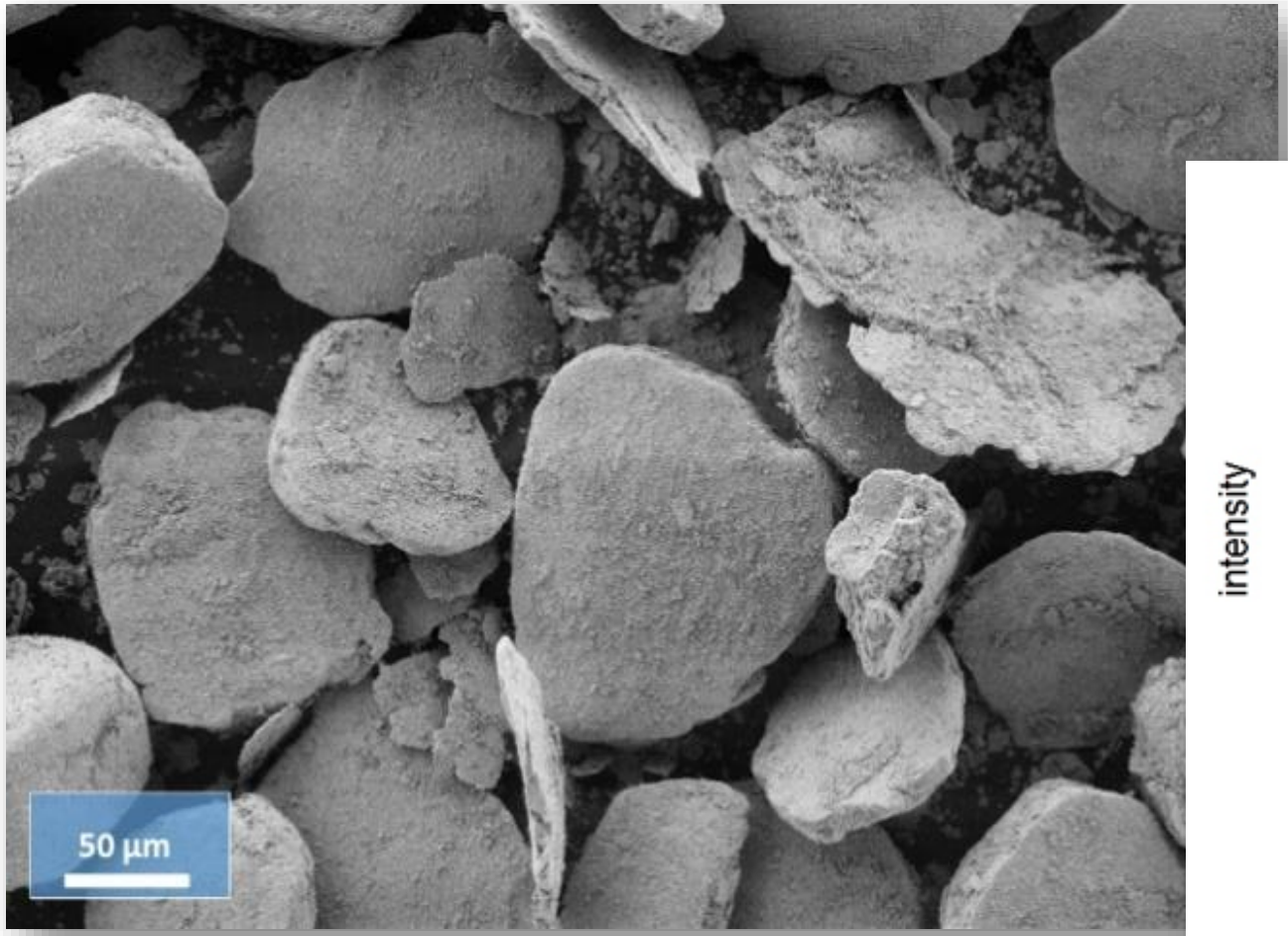


SEM image of sample after tribology test

Friction coefficient µ~ 0.8

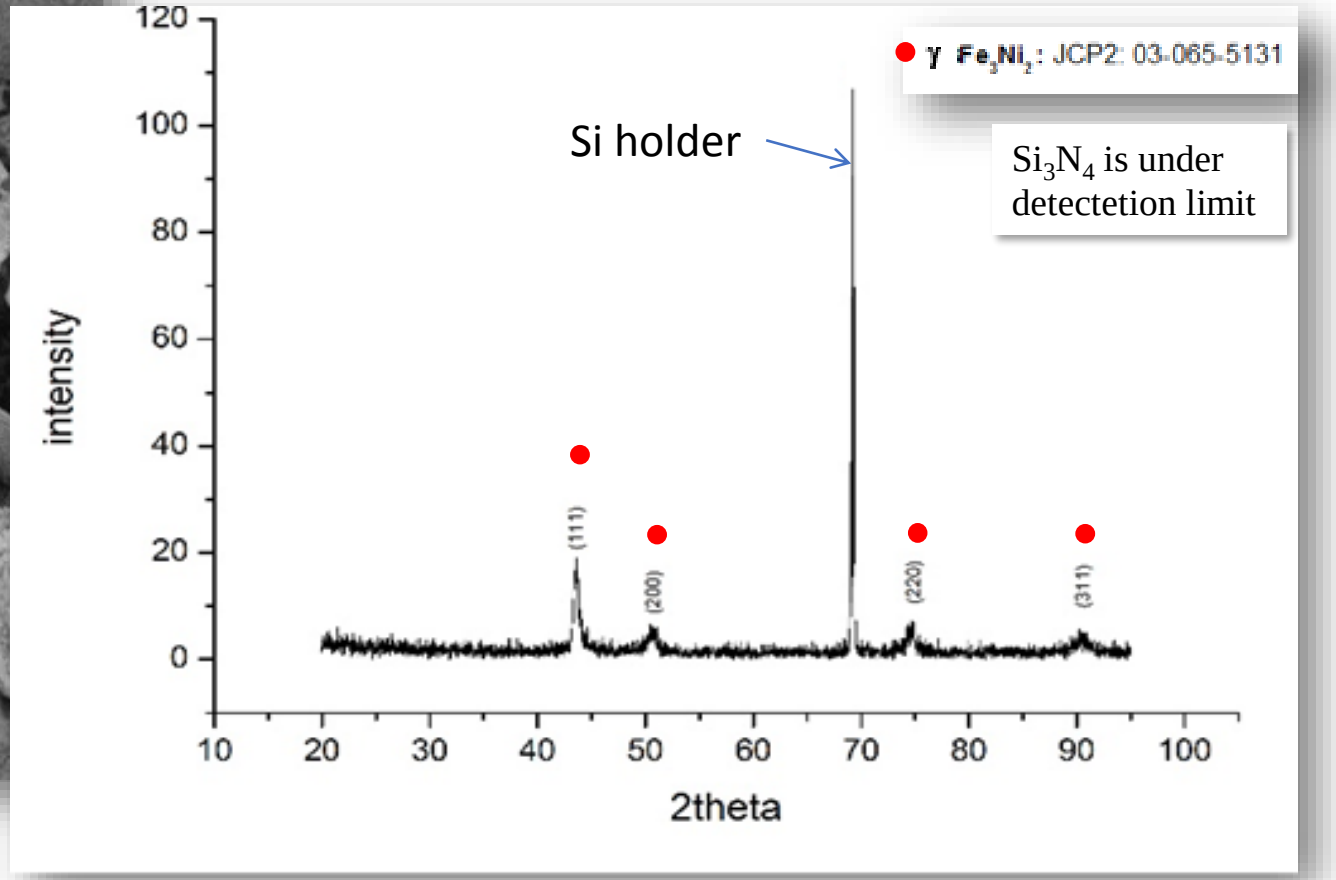
316L Höganäs + 1 wt% Si_3N_4

Structure of milled 316L / 1 wt% Si_3N_4

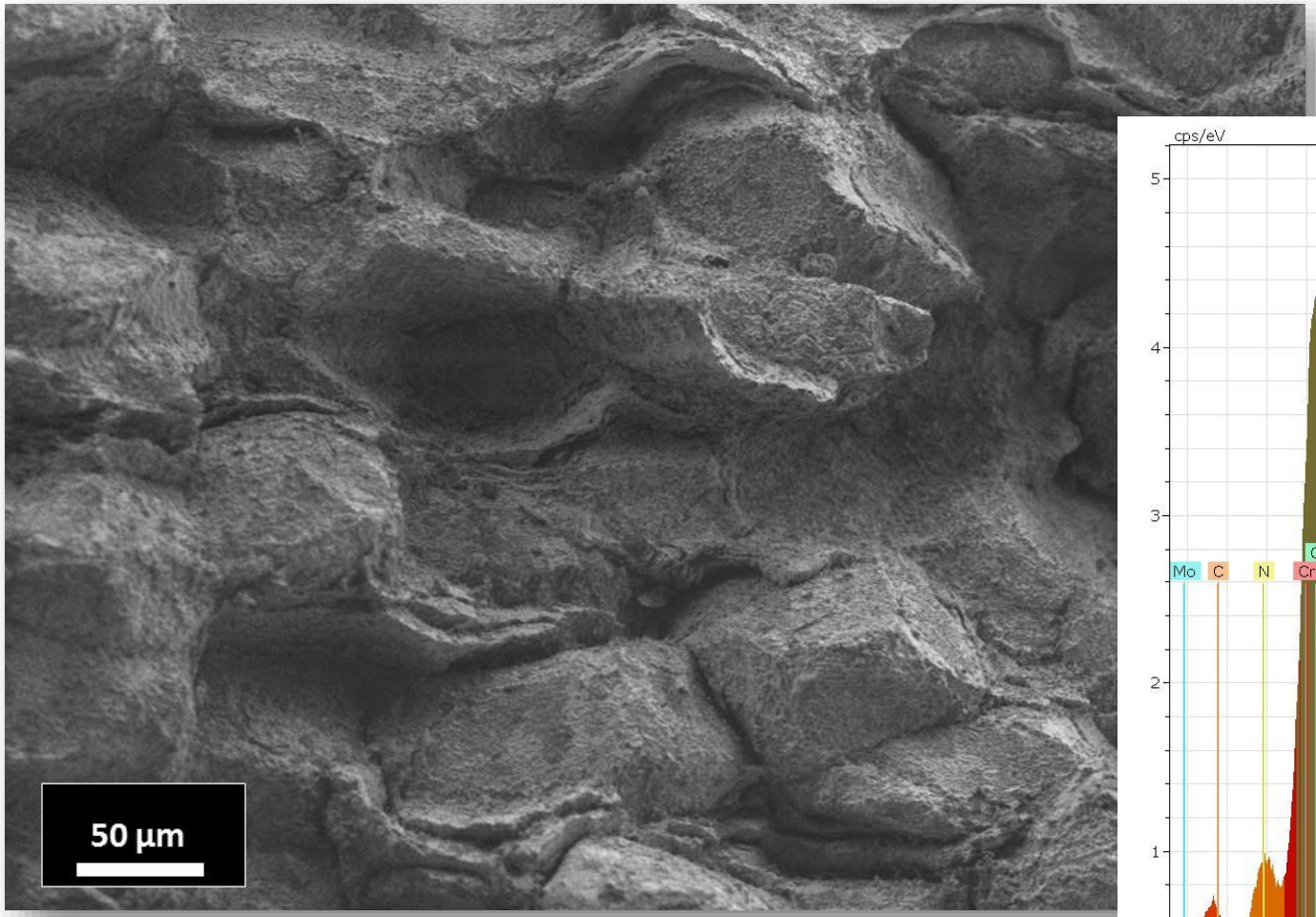


SEM image of milled powder with lamellar grains

XRD spectrum of milled powder

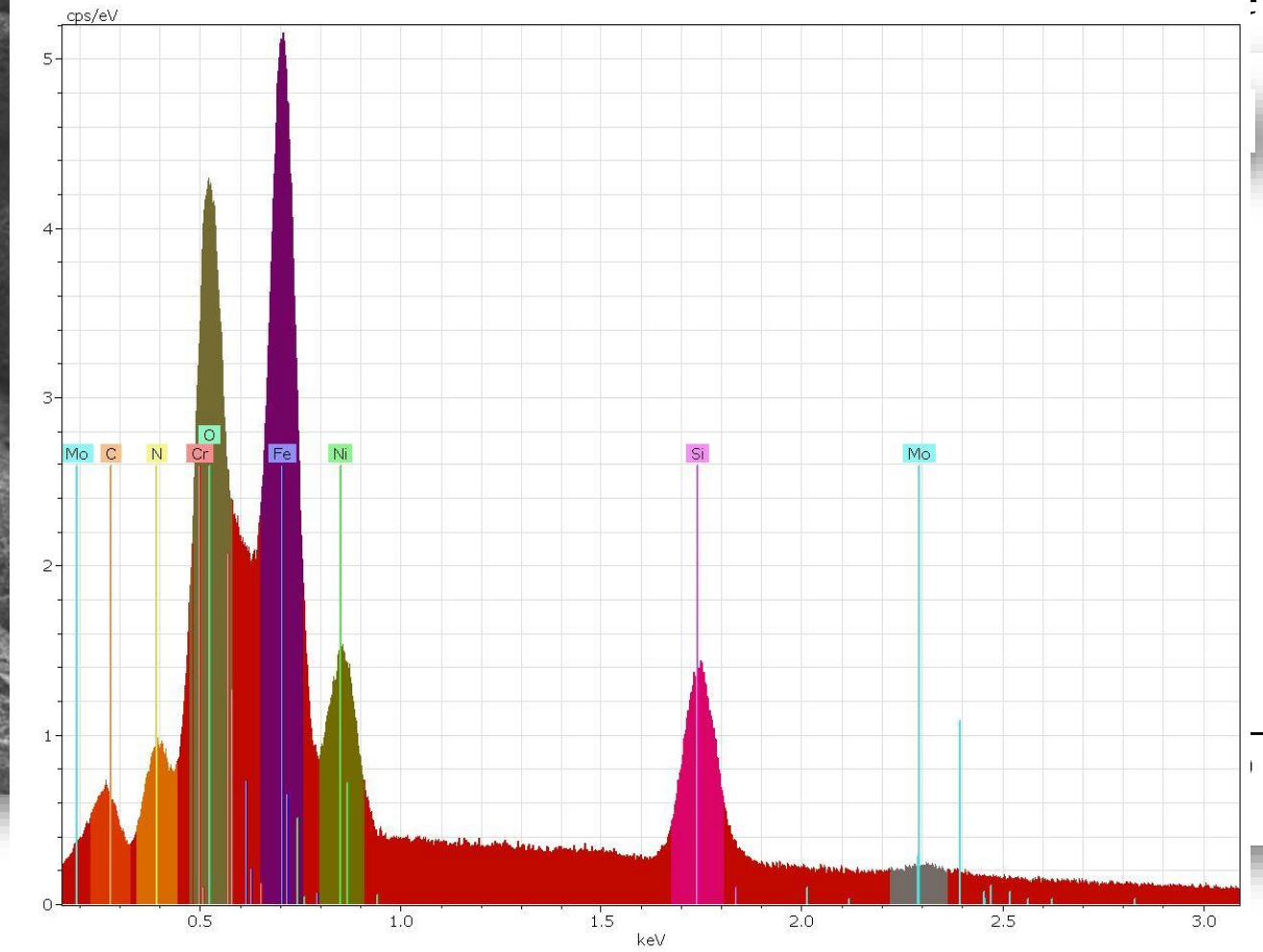


Structure of sintered 316L / 1 wt% Si_3N_4

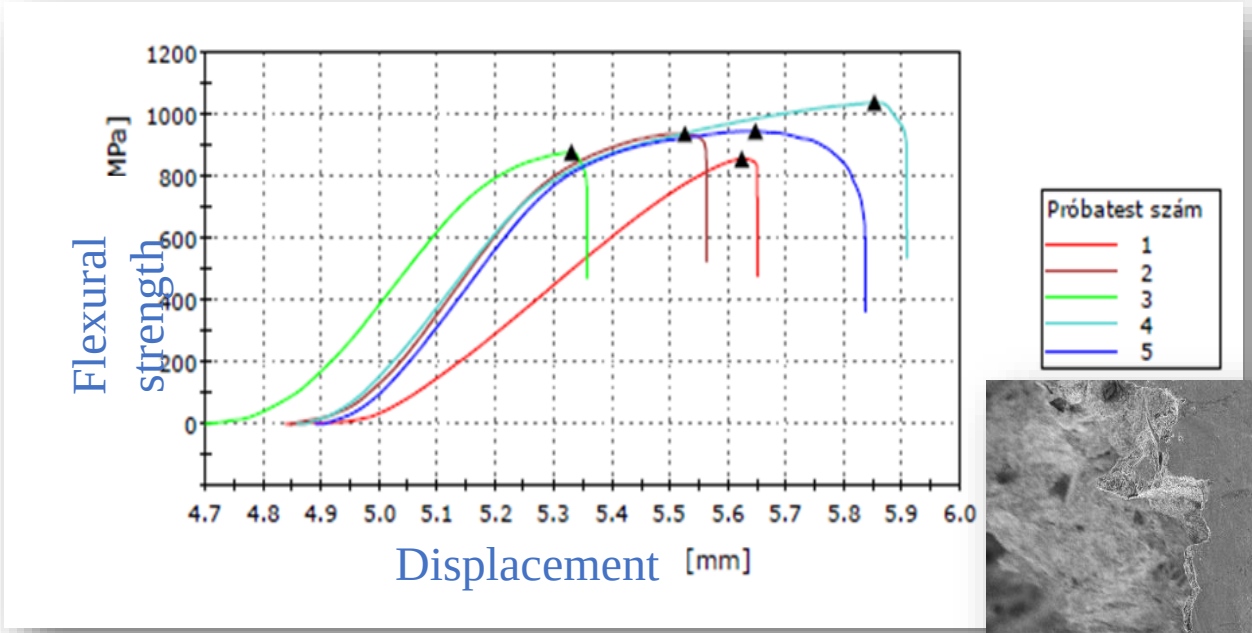


SEM image of fracture surface of sintered sample

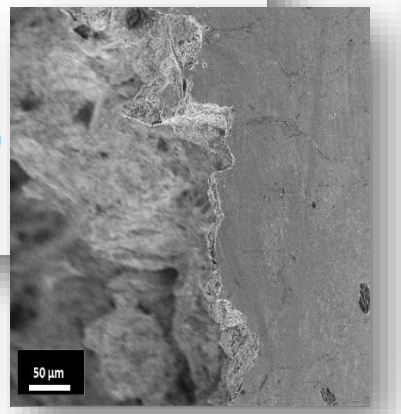
EDS spectra of the 316L+ 1wt %Si3N4 Sintered Sample



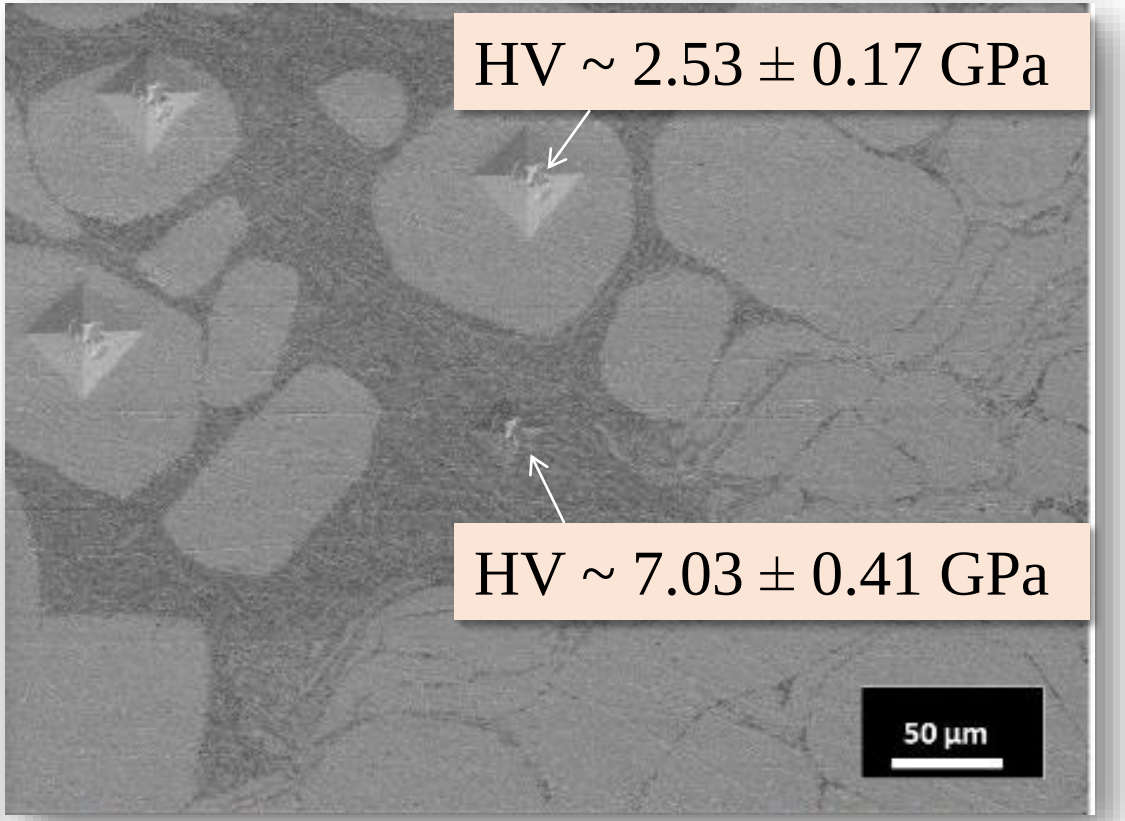
Properties of 316L / 1 wt% Si_3N_4



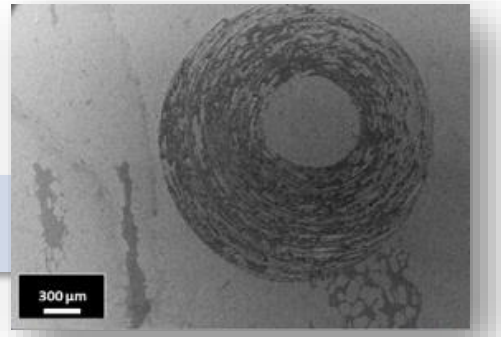
3 point bending stength measurements



SEM image of indentation



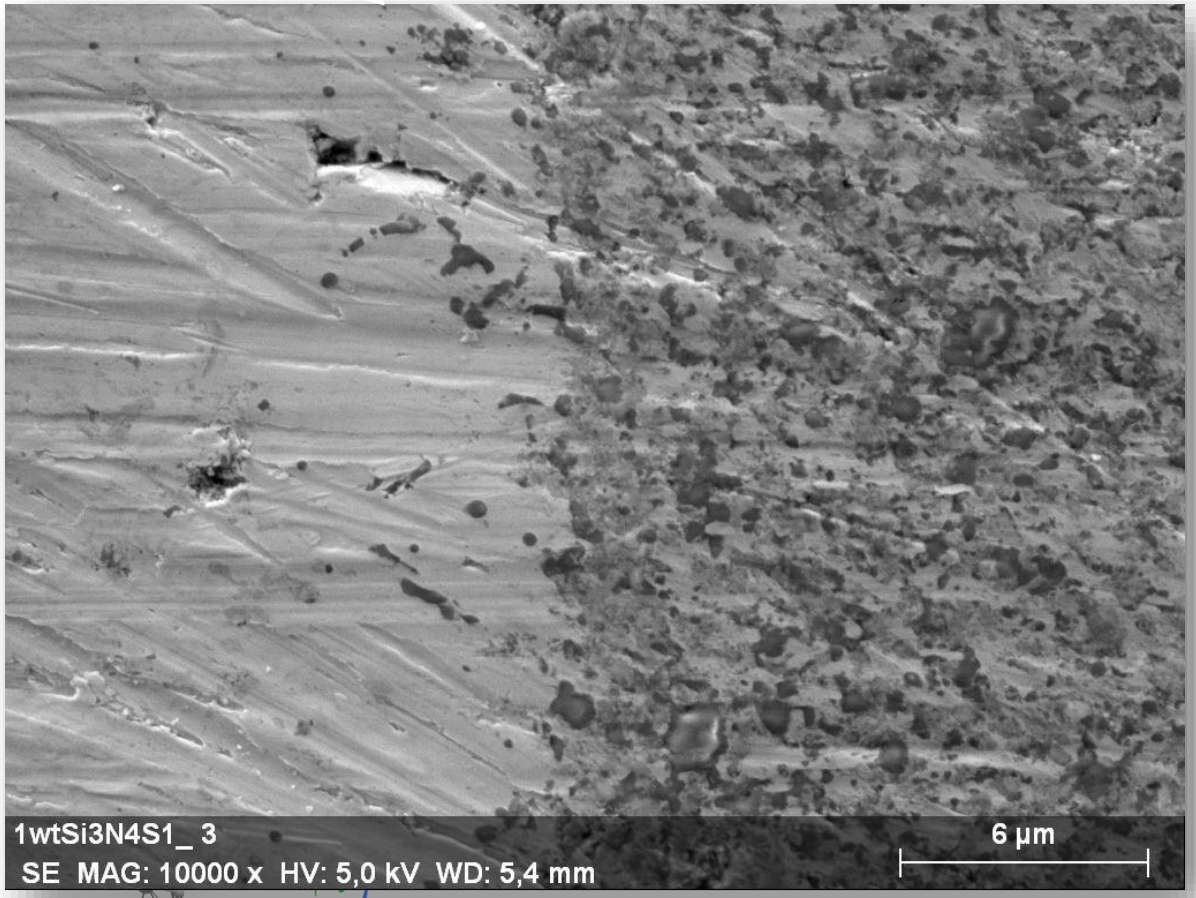
SEM image of sample after tribology test

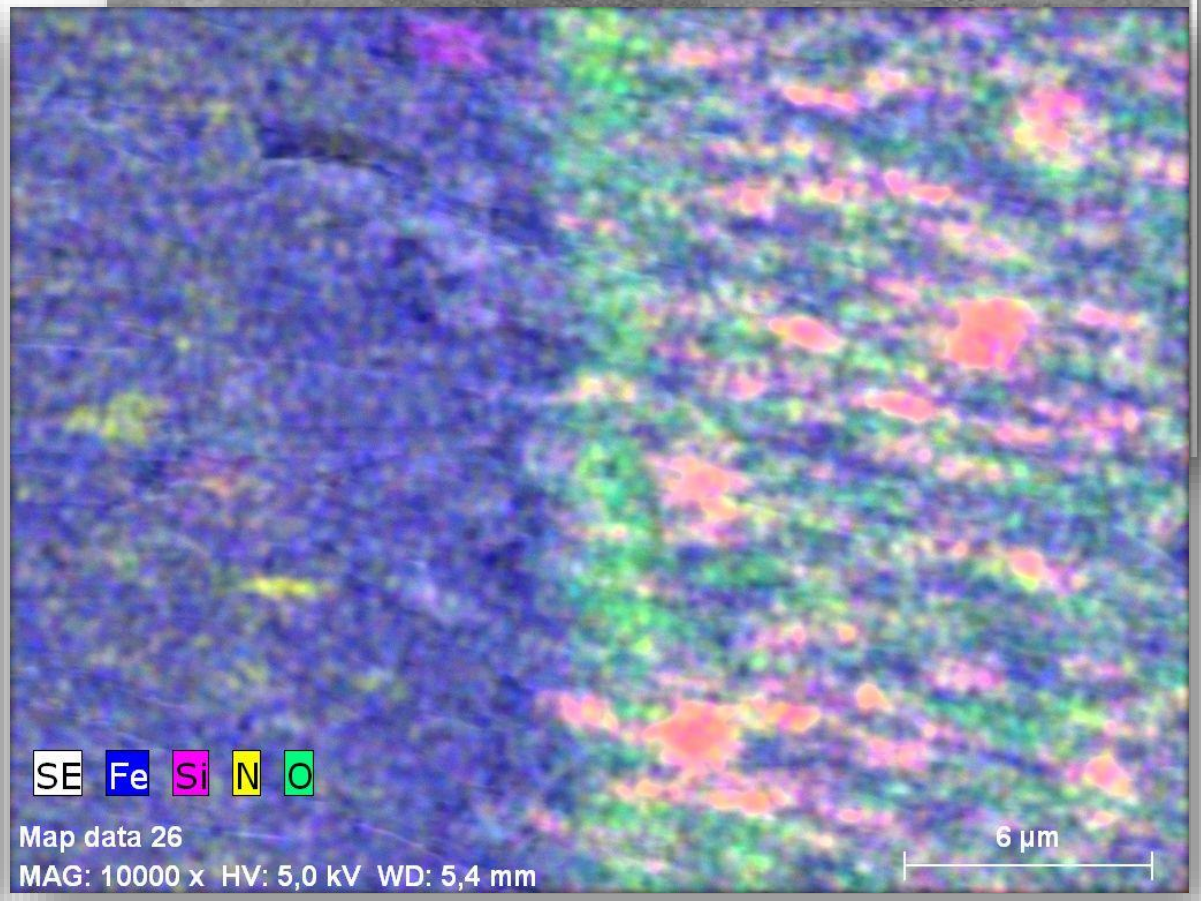


3p bending strength ~ 932 MPa (*5% error)

Friction coefficient μ~ 0.8

Elemental map of sintered 316 L / 1 wt% Si_3N_4

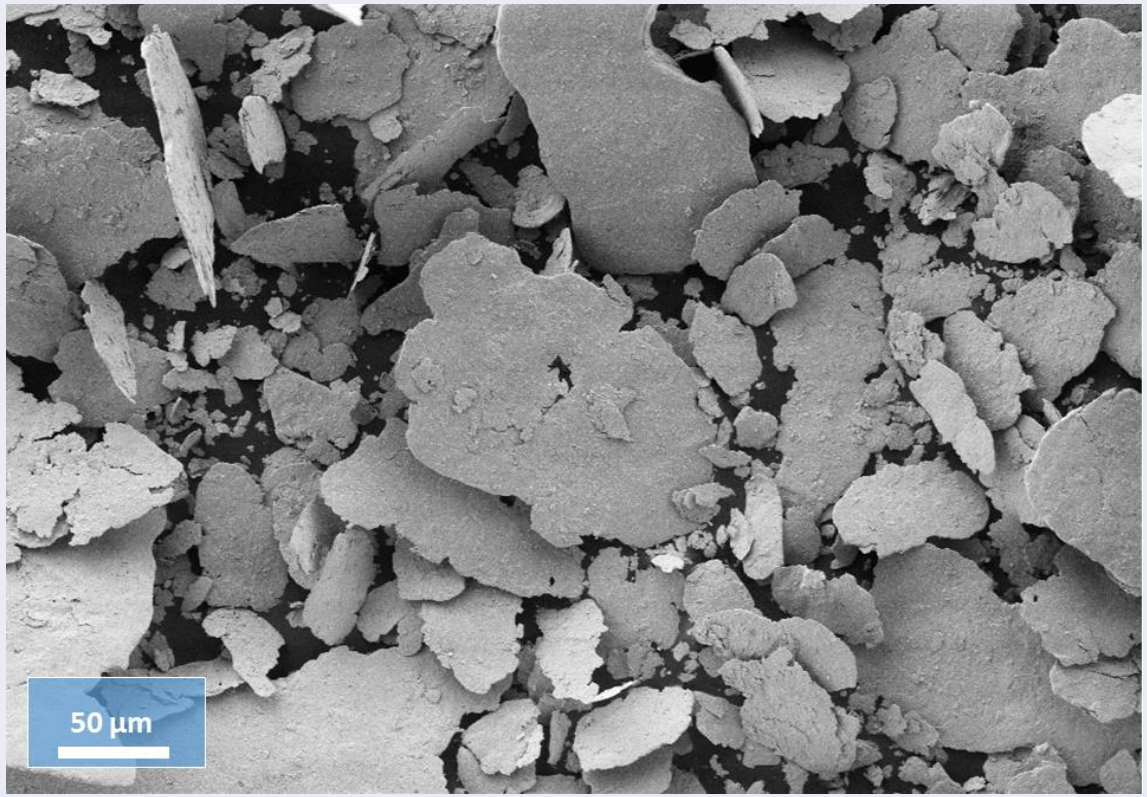




Results Comparison

Morphology after Milling Process

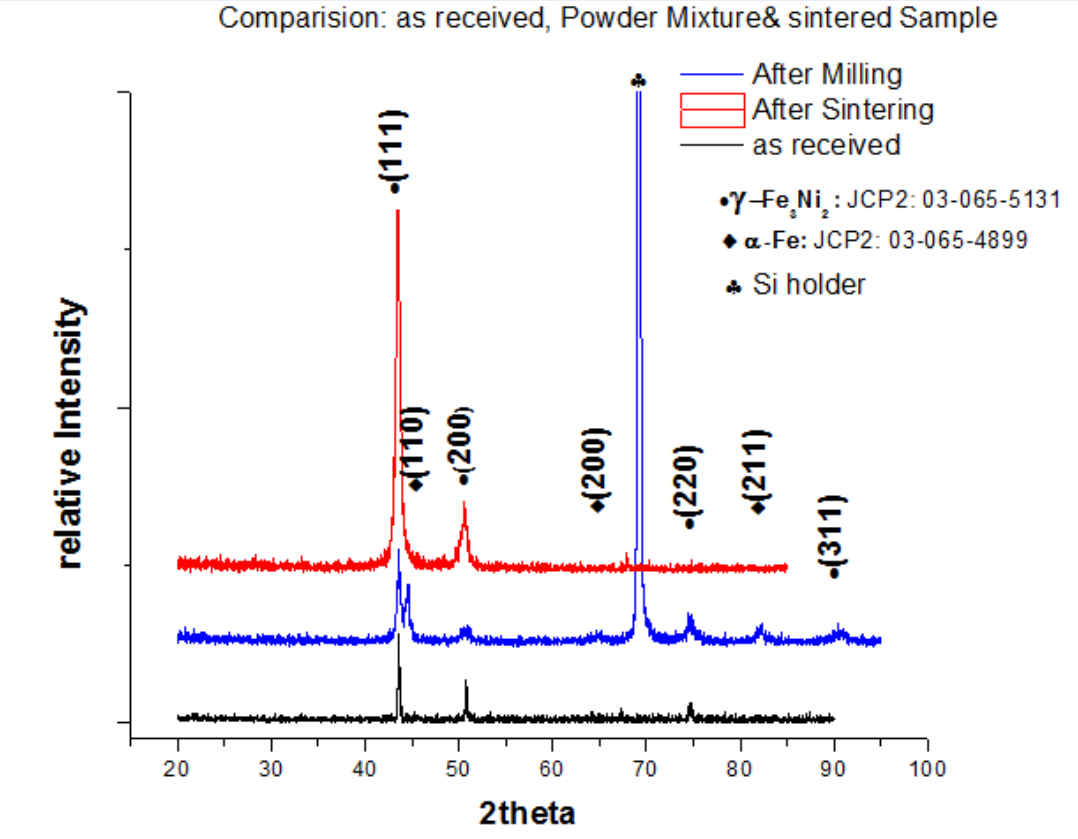
316L Hoganas +**0.33**wt% Si3N4



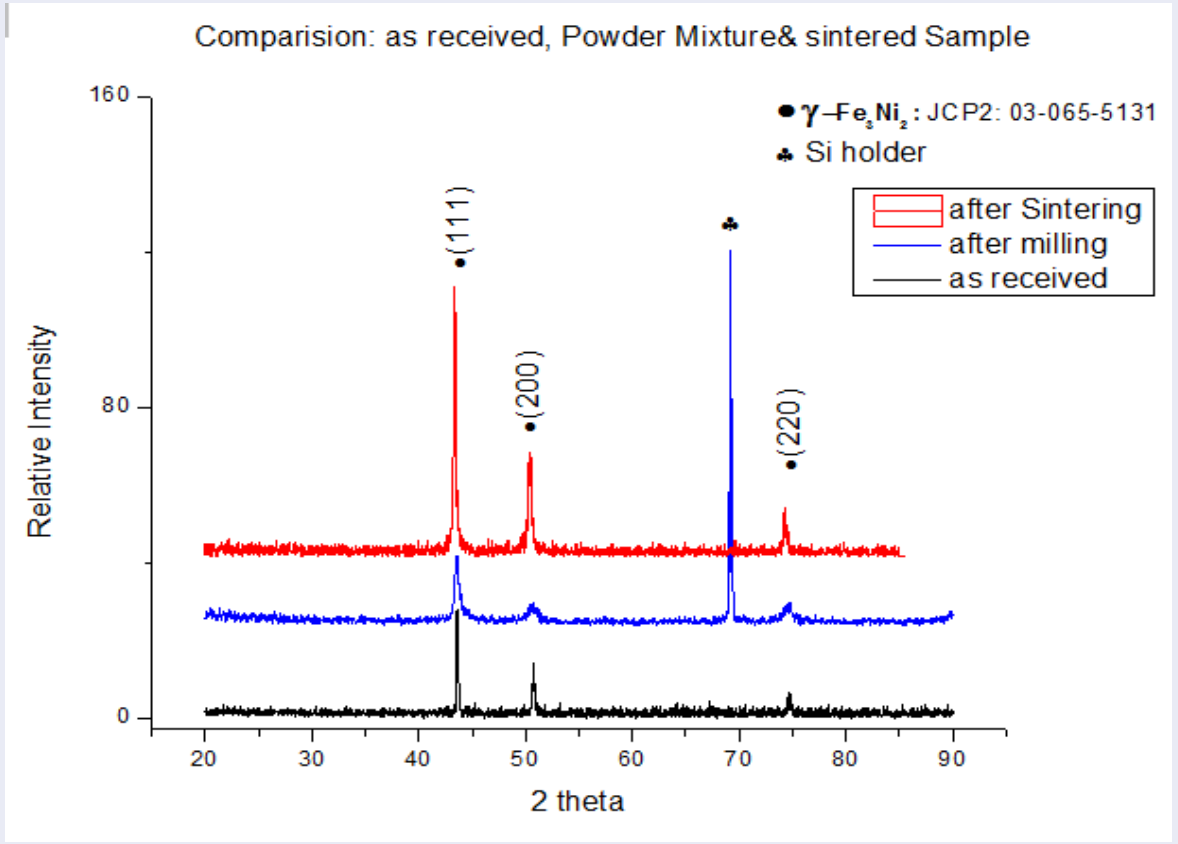
316L Hoganas +**1** wt% Si3N4

XRD

316L Hoganas +**0.33**wt% Si3N4

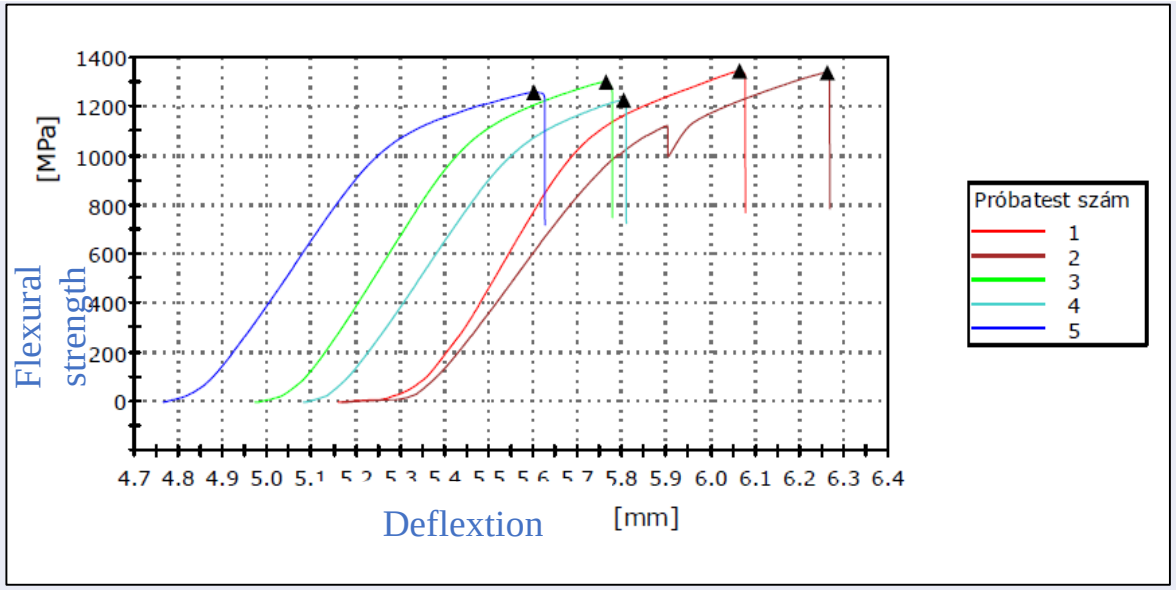


316L Hoganas +**1** wt% Si3N4



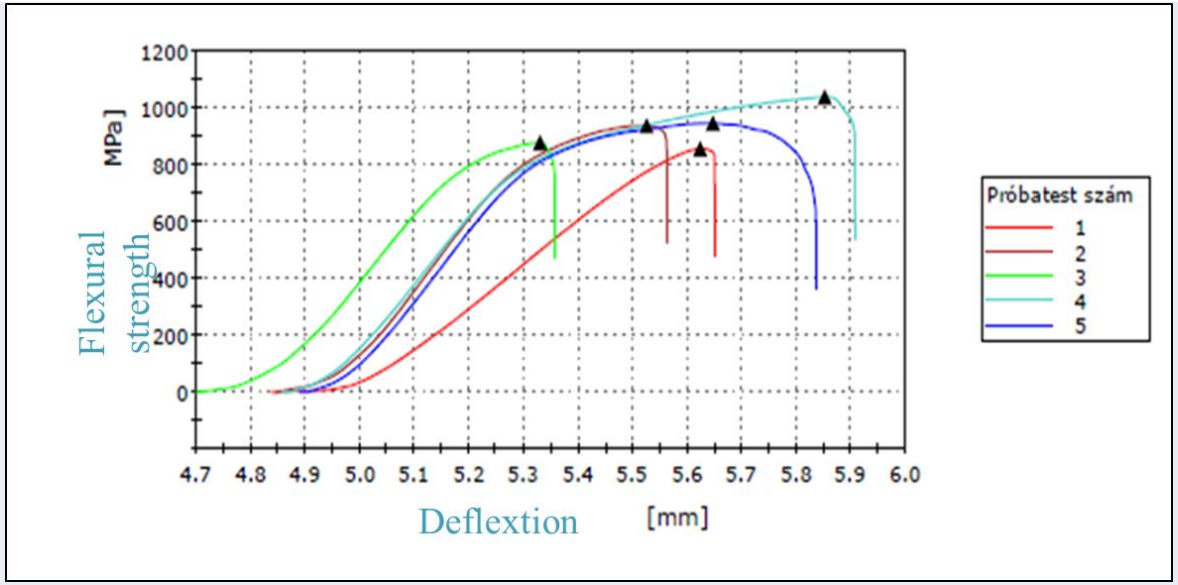
Three points Bending Test

316L Hoganas +**0.33**wt% Si3N4



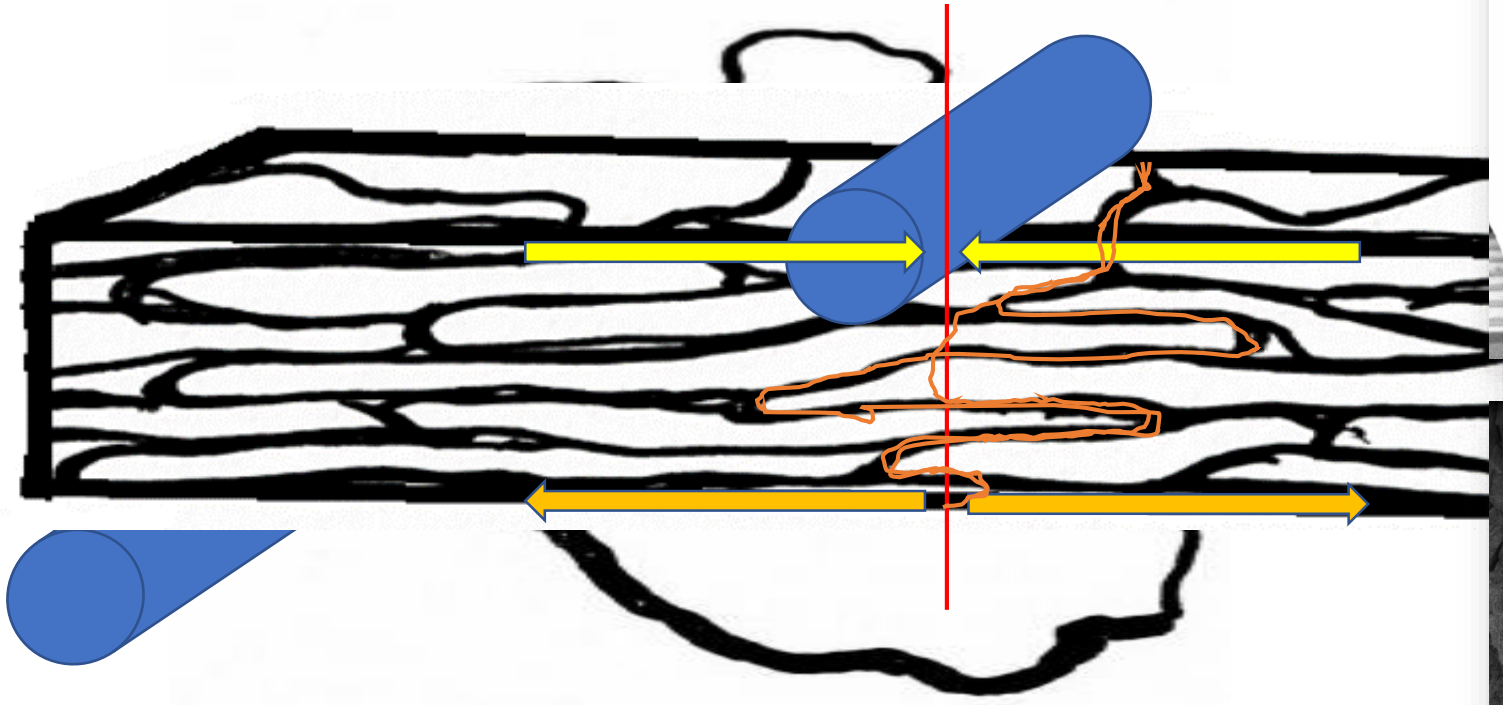
Test Number	Sample identifier	Flexural strength	Maximum load
1	0.33wtSi3N 1.1	1345	2225,2
2	0.33wtSi3N 1.2	1339	2645.1
3	0.33wtSi3N 1.3	1301	2601.8
4	0.33wtSi3N 1.4	1227	2699.5
5	0.33wtSi3N 3.1	1259	2963.5

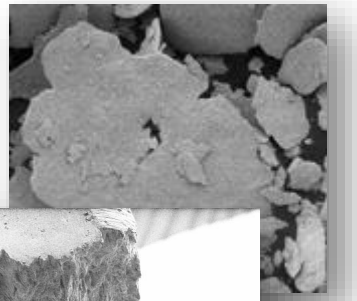
316L Hoganas +**1** wt% Si3N4

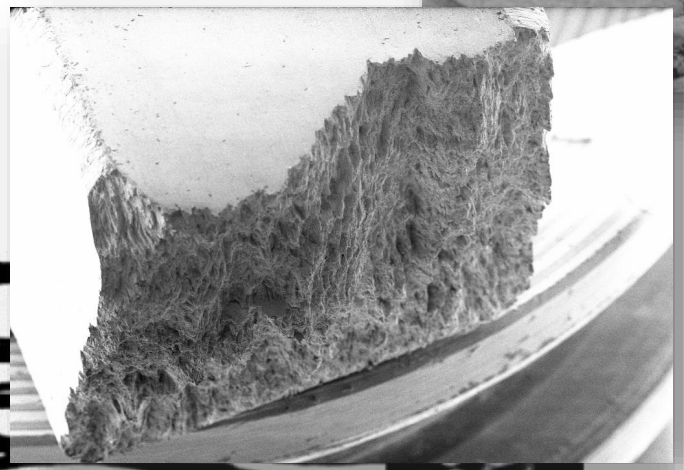


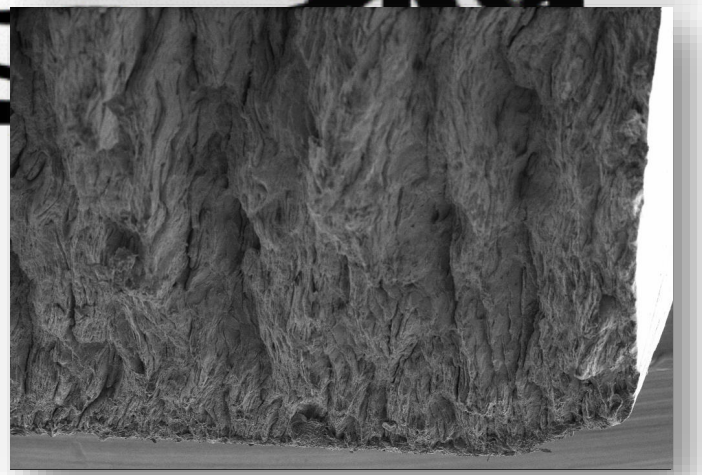
Test Number	Sample identifier	Flexural strength	Maximum load
1	1wtSi3N4-1	857	4202,7
2	1wtSi3N4-4	938	2022,9
3	1wtSi3N4-5	878	2087,5
4	1wtSi3N4-6	1039	2430,1
5	1wtSi3N4-7	947	2168,4

316L Höganäs + 0.33 wt% Si_3N_4

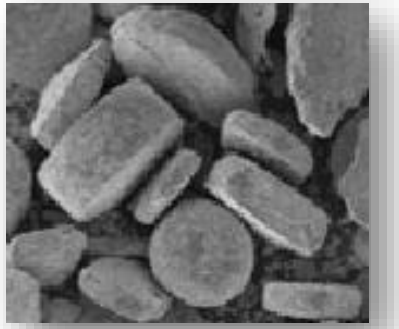


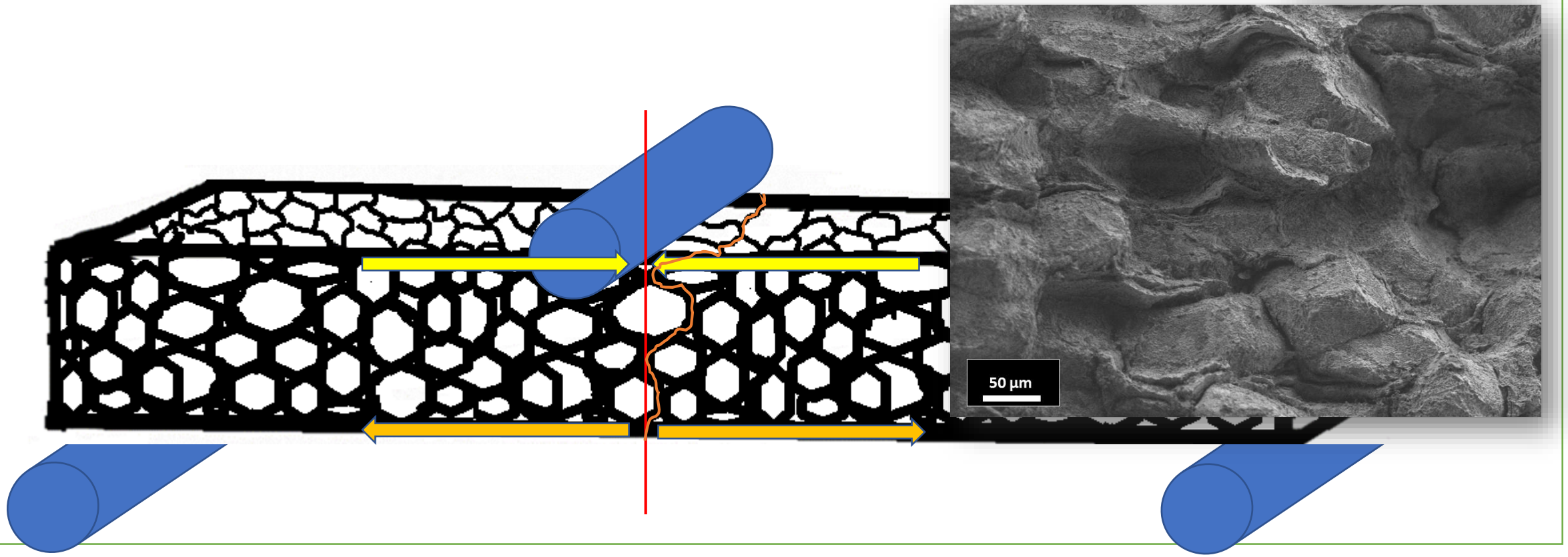






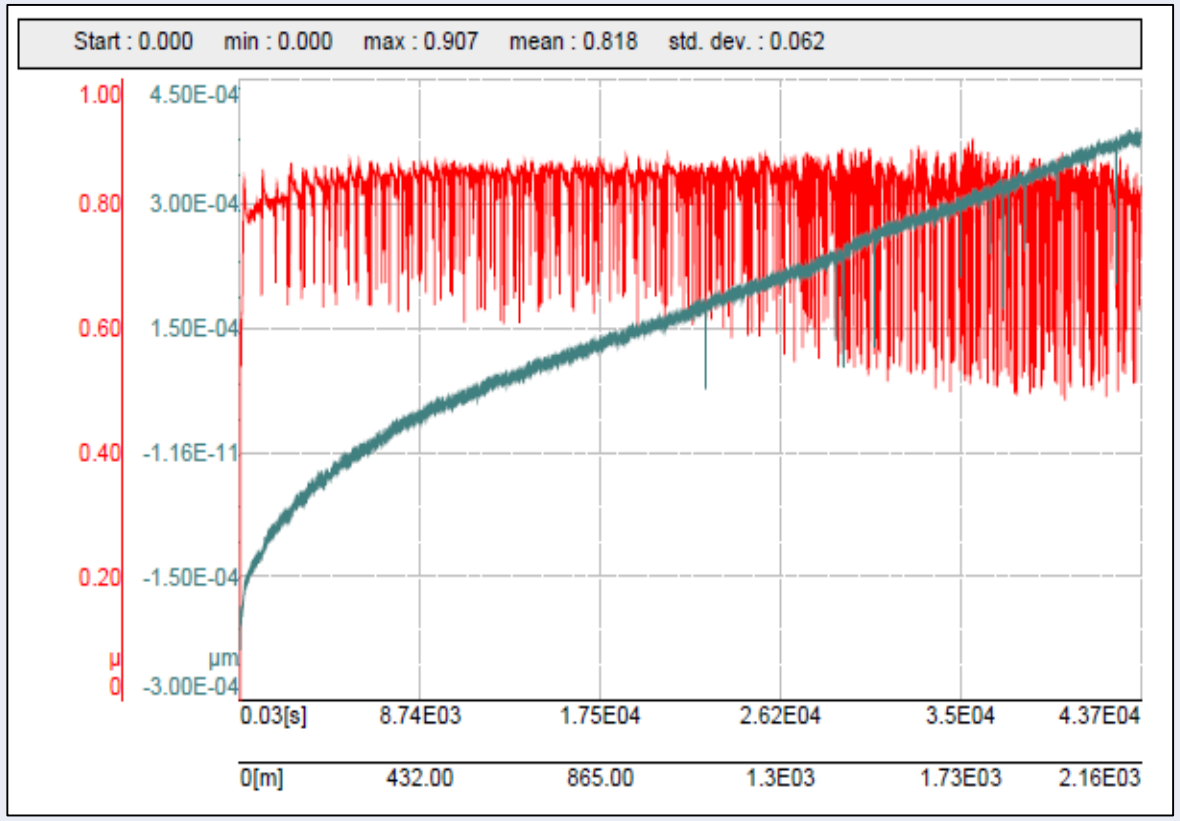
316L Höganäs + 1 wt% Si_3N_4





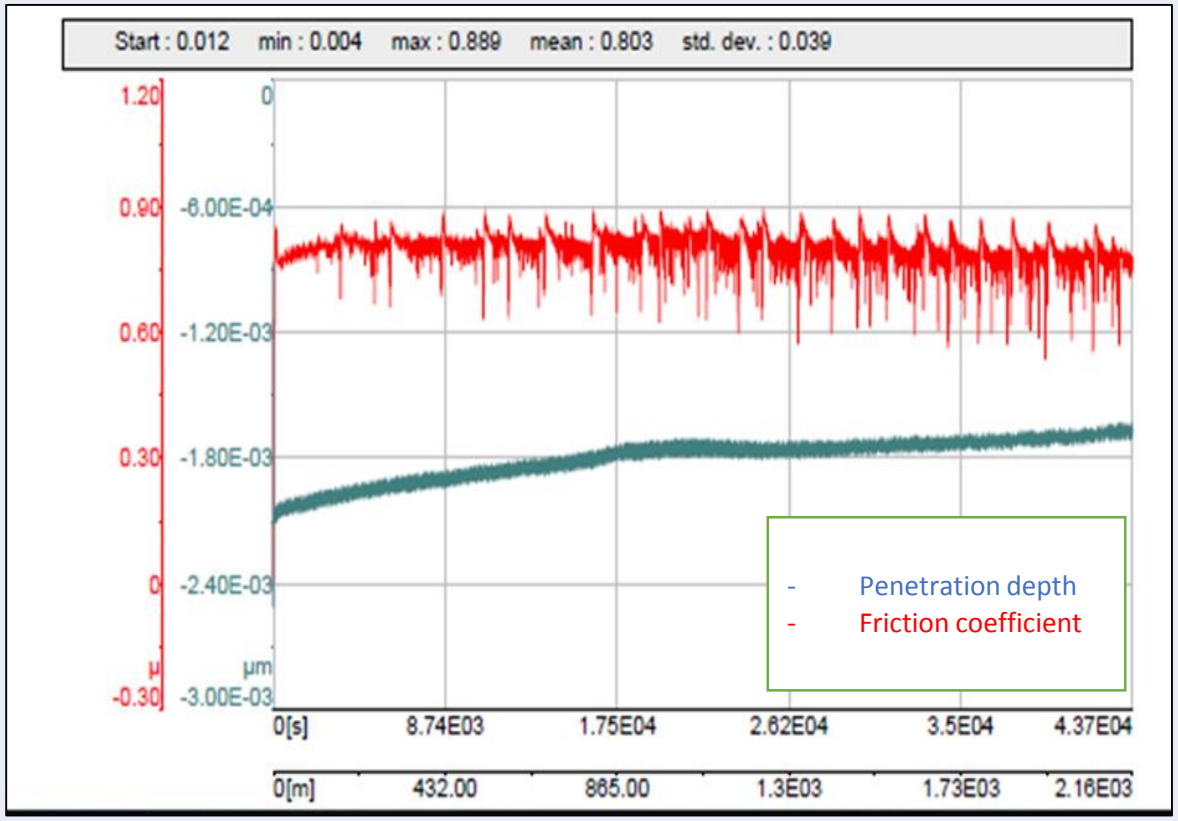
Tribology

316L Hoganas +**0.33**wt% Si3N4

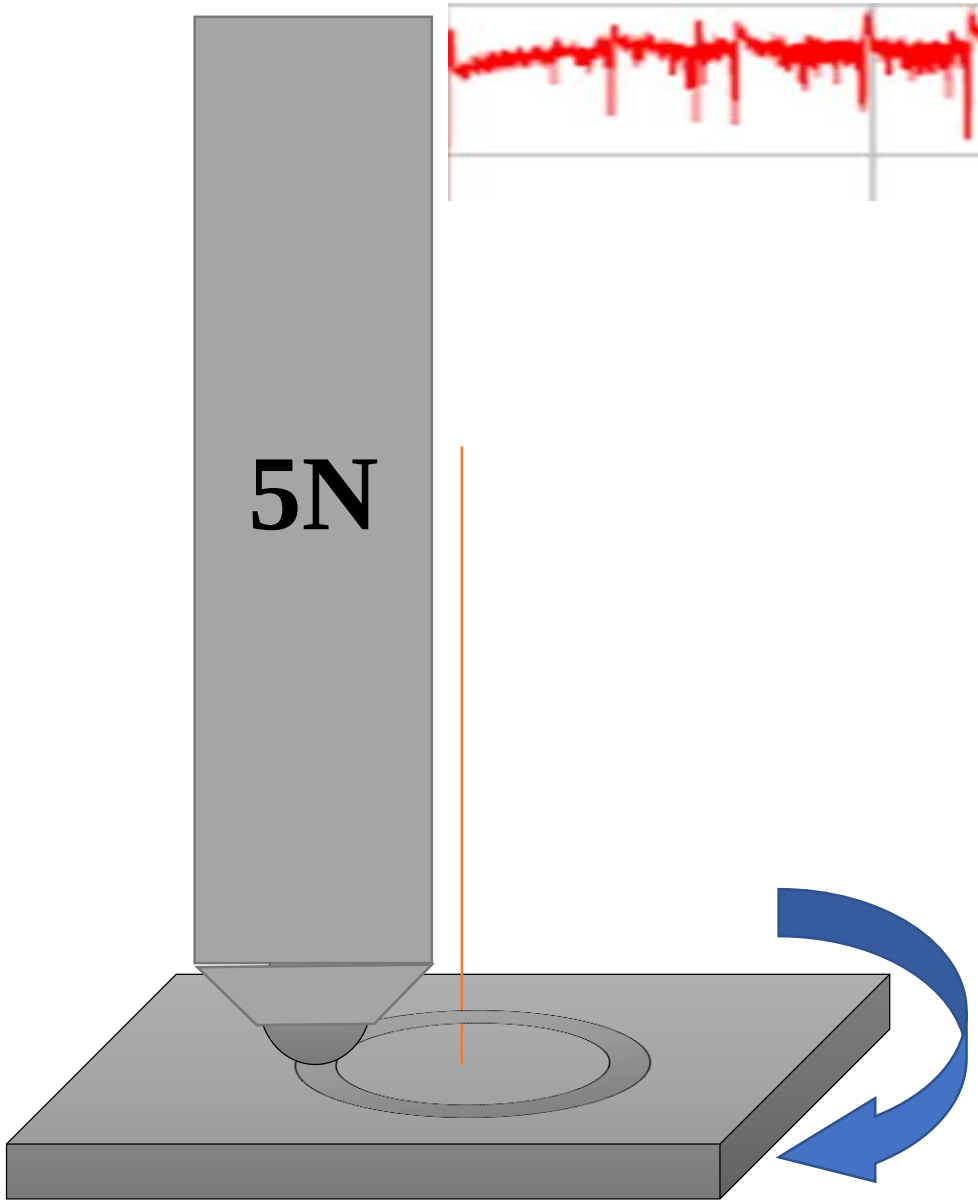


12 hours long tribology test results

316L Hoganas +**1** wt% Si3N4



12 hours long tribology test results


5N

Conclusions

- Powder technology has been used for ceramic dispersed steel preparation
- 0.33 wt% Si_3N_4 addition provided high efficient milling than 1 wt% Si_3N_4

  flat 316L grains structure at 0.33 wt% Si_3N_4

  milling effect at 0.33 wt% Si_3N_4 - α Fe presence

- Higher 3 point bending strength at 0.33 wt% Si_3N_4 than 1 wt% Si_3N_4
- Higher hardness (7.03 GPa) at intergranular parts compared to steel grains (2.53 GPa)
- The friction coefficient was independent of Si_3N_4 content

Results of the Actual semester:

- Preparation of the solid samples for investigation(mechanical surface preparation, water jet cutting, Making modifications on the cutting machine, Making polishing sample holder).
- Structural investigation of the samples (XRD, EDS, SEM and TEM).
- Learning how to use the tribology test apparatus
- Mechanical investigation of the samples (three points bending test).
- Participating in the first seminar on “thin films and their applications” at Mohamed khider University, Biskra in Algeria by Oral Presentation (40 minutes) on the 16/04/2017
- Participating in MMT conference in Siofok with Oral Presentation 13/05/2017 (20 minutes)
- Preparing an article to be published in “resolution and discovery” journal
- Preparing a poster for ECERs conference in July 2017, Budapest Hungary

Taken Subjects: **UNFORTUNATELY I DON’T HAVE ☹**

Results after the second year:

- Participating in SMINS-4 in Manchester by poster & **short oral presentation** ,H.R. Ben Zine, C. Balázsi, K. Balázsi, A. Horváth, Development of nanostructured ODS steels by powder technology, NEA International Workshop on Structural Materials for Innovative Nuclear Systems, 11-14 July 2016, Manchester, UK, **Poster.**

- Attending the MMT (Hungarian Microscopy Society) Conference in Siófok, 2016. May 19-21

- Participating in the 14th International Symposium on Novel and Nano Materials, 2016. July 3-8,H.R. Ben Zine,
- F.S. Cinar, O. Yucel, K. Balázsi, A. Horváth, C. Balázsi, Preparation and Investigation of Boron Nitride Dispersion Strengthened Steels, **presentation.**

- Participating in '' SIXIEME ECOLE SUR LES TECHNIQUES DE CARACTERISATION DES MATERIAUX '' by **video conference**

- Participating in **Webinar** conference about « orgonizing research work and time »

- Submitting **a paper** in '' Courier de Savoir'' Journal (1.16 UIF (Universal Impact factor)).

- Participating in the first seminar on "thin films and their applications" at Mohamed khider University, Biskra in Algeria by Oral **Presentation (40 minutes)** on the 16/04/2017

Results after the second year:

- Participating in MMT conference in Siofok with **Oral Presentation** 13/05/2017 **(20 minutes)**
- Preparing **an article** to be published in “resolution and discovery” journal
- Preparing a **poster** for ECERs conference in July 2017, Budapest Hungary

Future work Plan:

- Continuing the investigation the Si_3N_4 Alloys
- Prepare a paper to be published in high impact factor from the obtained results (with Si_3N_4)
- Start the investigation of the other alloys (316L+ SiC/ Y_2O_3/ Al_2O_3)
- prepare other papers for publications


THANK YOU FOR YOUR ATTENTION