Óbuda University – Doctorate School on Materials Science and Technologies Obuda University, Hungary

Testing in Semi-Solid Rheocasting (SSR)

Testing in Semi-Solid State

by

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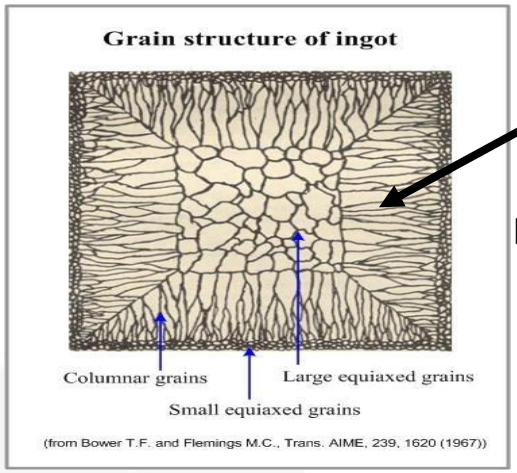
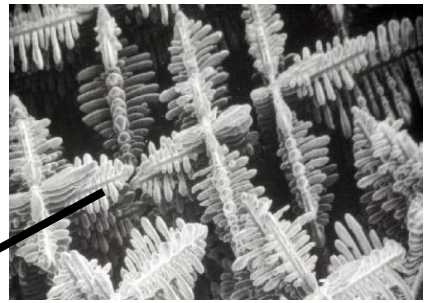
Outline

- ✓ Background of Dendritic and Non-Dendritic Structure
- ✓ Semi - Solid Methods
- ✓ Previous work
- ✓ Aluminum Alloy
- ✓ The SSR feedstocks
- ✓ Process Window
- ✓ Results and Conclusion
- ✓ Activity in This Semester
- ✓ Future Research Plan

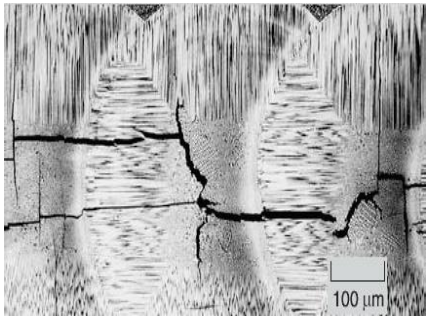
Dendritic and Non-Dendritic Structure

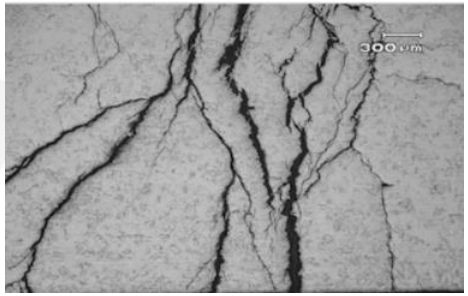
What is dendritic structure?





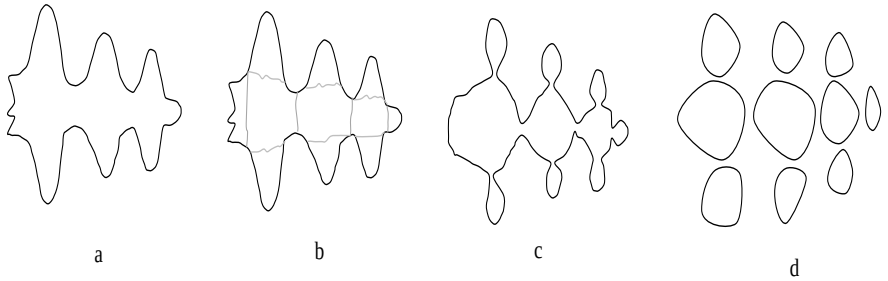
Dendritic structure of material





Failure Arm Dendritic structure

Microstructural changes



Dendritic arm structure

Spheroidal shape

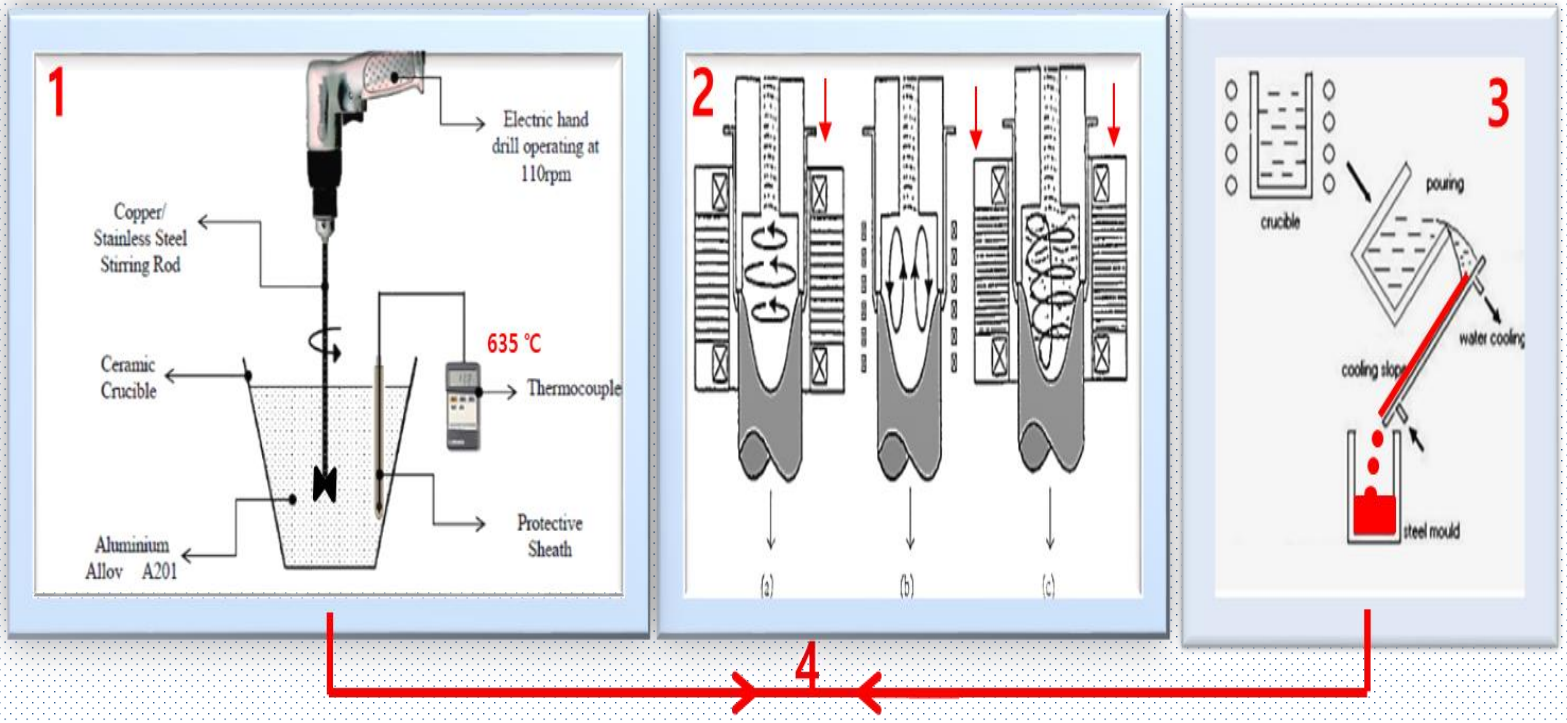
(a and b) The shear stresses change the shape of the solid particles from dendritic (c and d) to globular

What is Semi-Solid State?

Background of Semi-Solid

Semi - Solid Methods

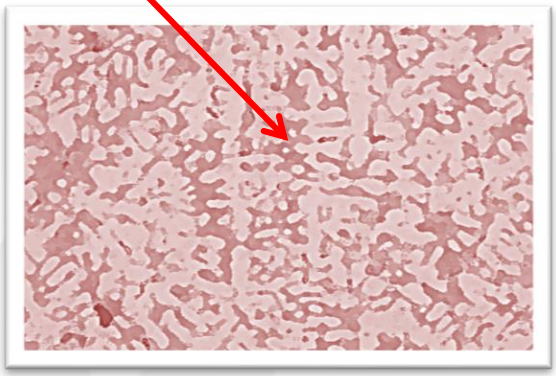
1. Semi-Solid Rheocasting (SSR) process
2. Magneto Hydrodynamic (MHD) Method
3. Cooling Slope Method
4. SSR with CS techniques



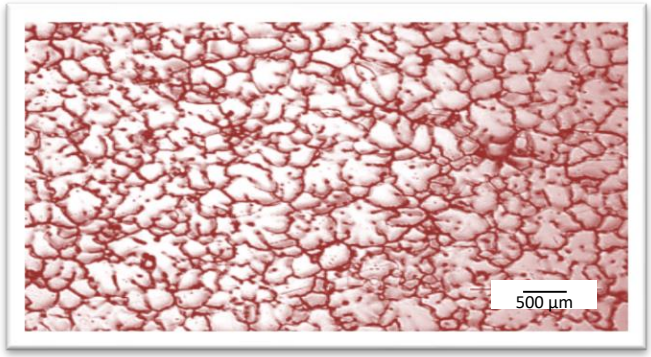
Previous work

Microstructure Results

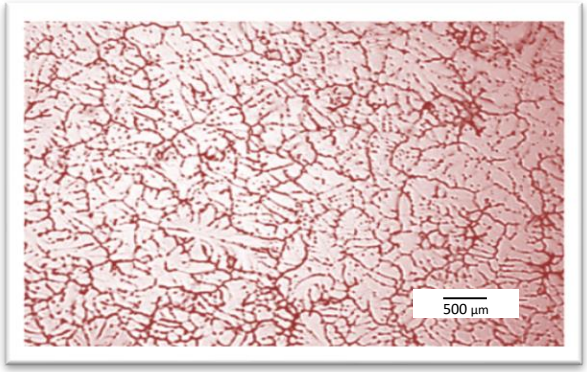
Dendritic structure



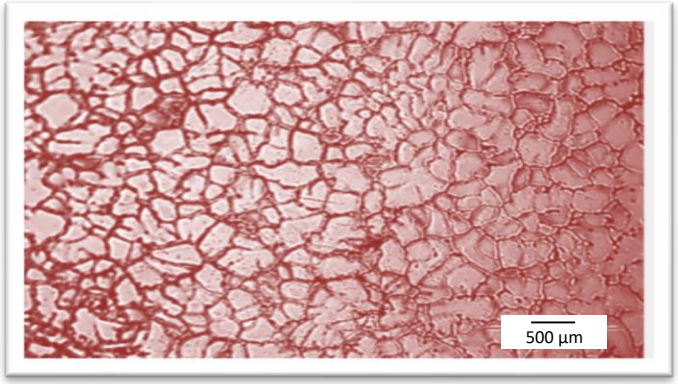
Dendritic Microstructure



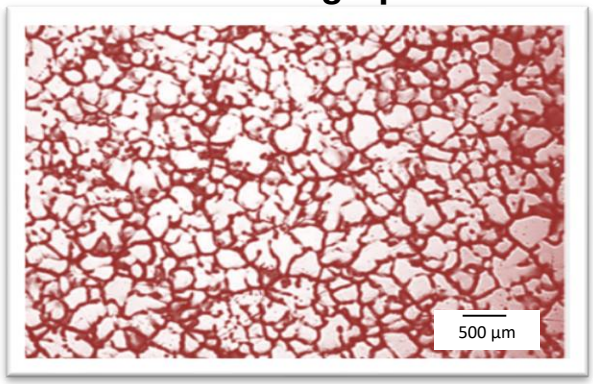
CS Micrograph



MHD Micrograph



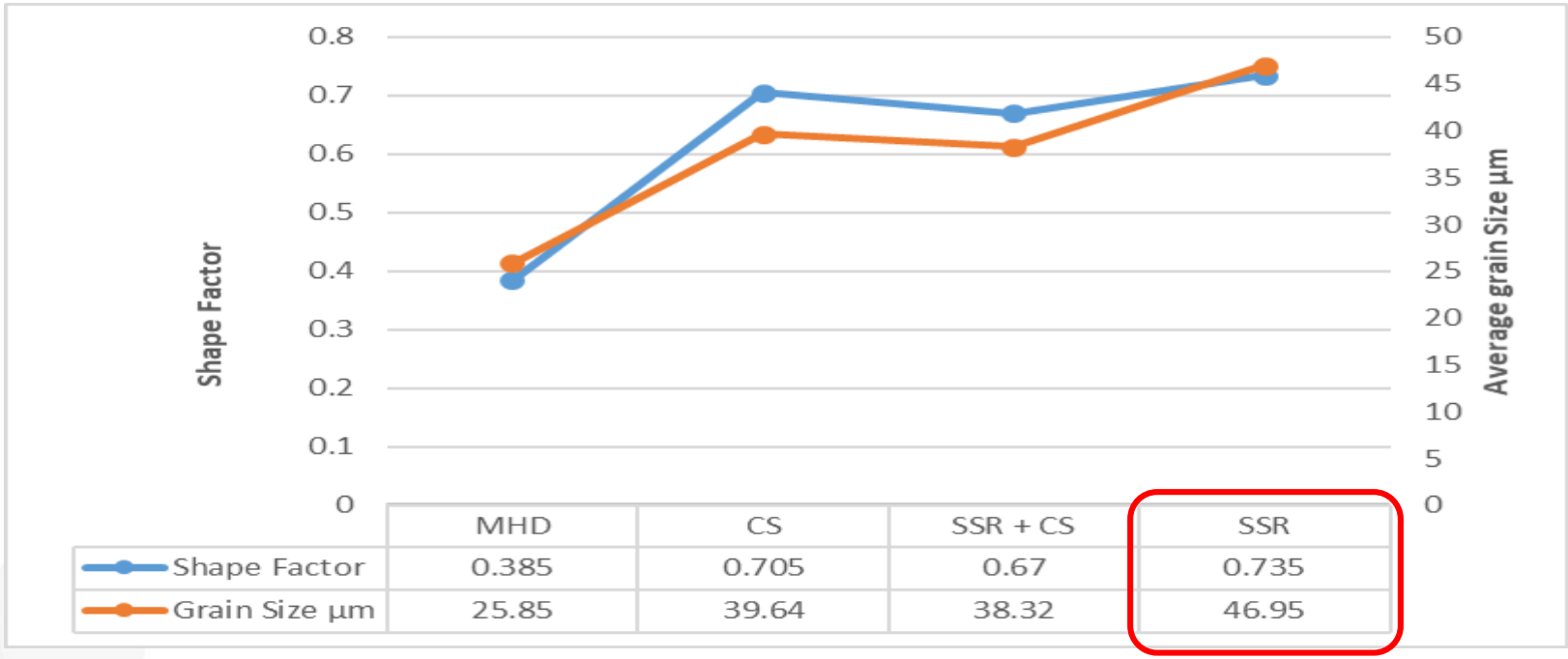
SSR Micrograph



SSR + CS Micrograph

Previous work

Microstructure Results



	MHD	CS	SSR + CS	SSR
Shape Factor	0.385	0.705	0.67	0.735
Grain Size µm	25.85	39.64	38.32	46.95

Shape Factor and Grain size of variance types of Alloy A201

Shape Factor (*Solid Fraction*) **=** $4\pi A / P^2$

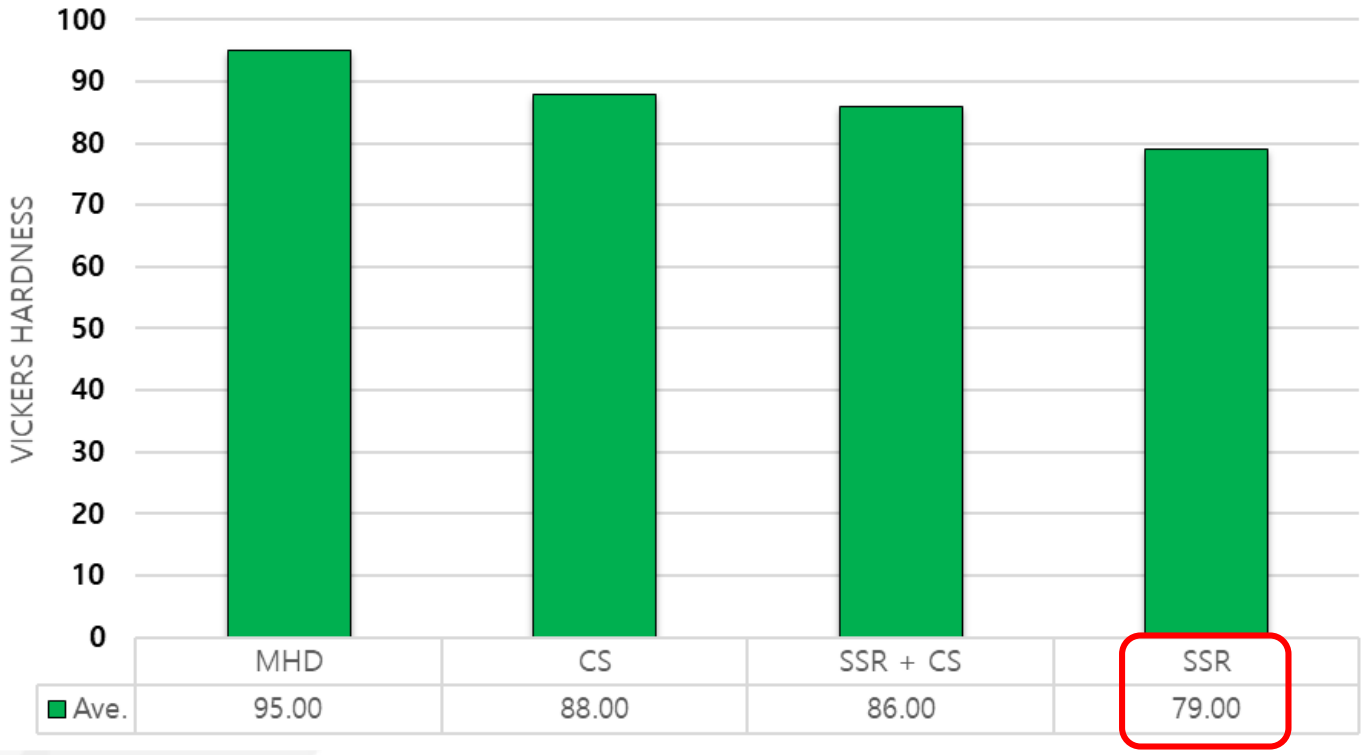
P = the average perimeter.

A = the average area of the grains

S. F. = value should be between 0.6 and 1.0

Previous work

Mechanical Properties Results Results



Vickers Hardness of all Methods

Aluminum Alloy

Mechanical Properties of Aluminium EN 6063 - T6 Extrusions alloy and Semi-Solid Rheocasting Alloy

Aluminium EN6063-T6 Extrusions alloy

Source (wt%)	Al	Si	Mg	Ca	Fe	Mn	Cr	Zn	Ti	Cu
EN6063-T6	Bal.	0.6	0.9	0.001	0.26	0. 1	0.25	0.001	0.1	0.002

Major alloying

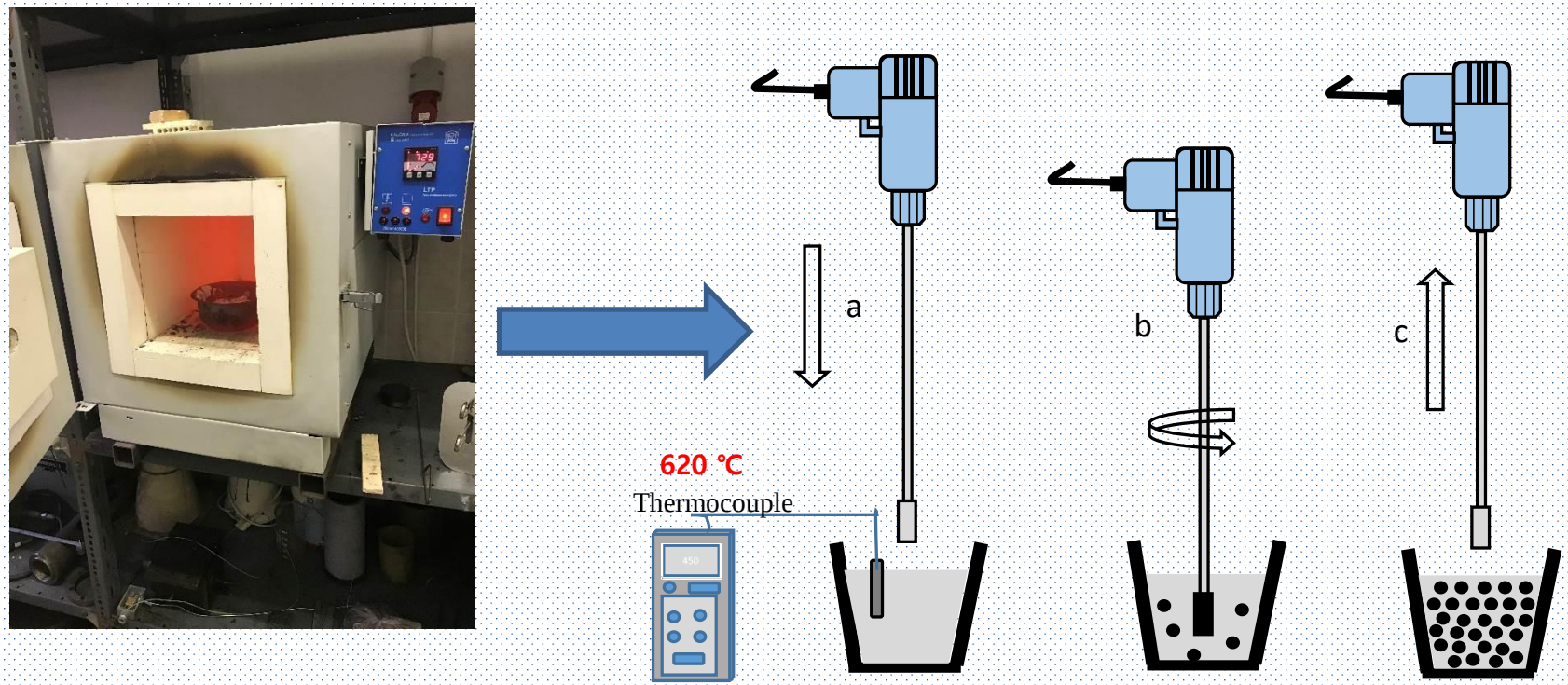
Advantages:

- High mechanical properties,
- Good formability in the temper T4,
- Excellent machinability
- Good corrosion resistance

Application:

- Aerospace applications,
- Military bridges, Motorboats
- Transport cases.

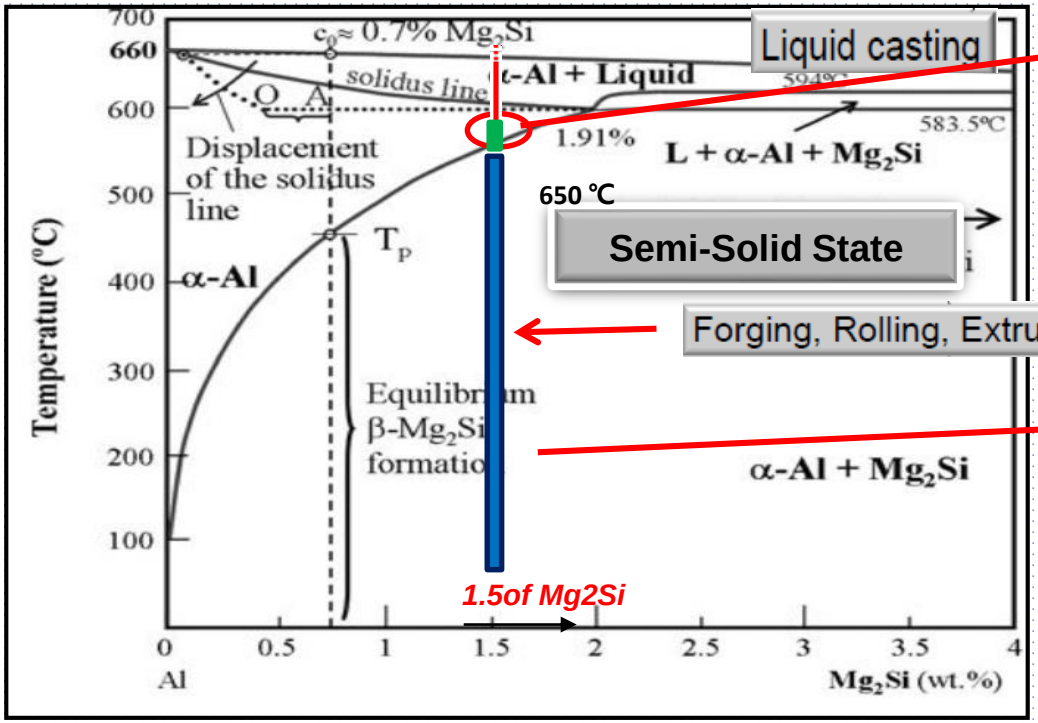
The SSR feedstocks



Rheocasting process active in the present work: (a) solid block of the same alloy prepared in advance, attached to a stainless steel rod, (b) dissolved in the melt with simultaneous stirring action, and (c) the slurry thus produced.

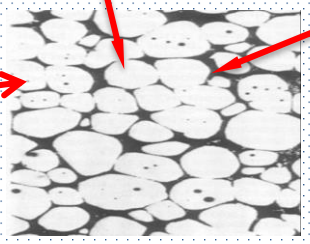
How can get Semi - Solid State?

Semi-Solid Process Window

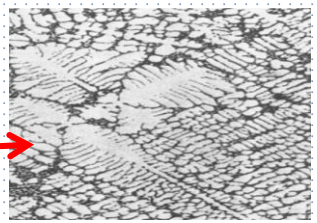


Spheroidal solid

Liquid



Non-Dendritic Microstructures

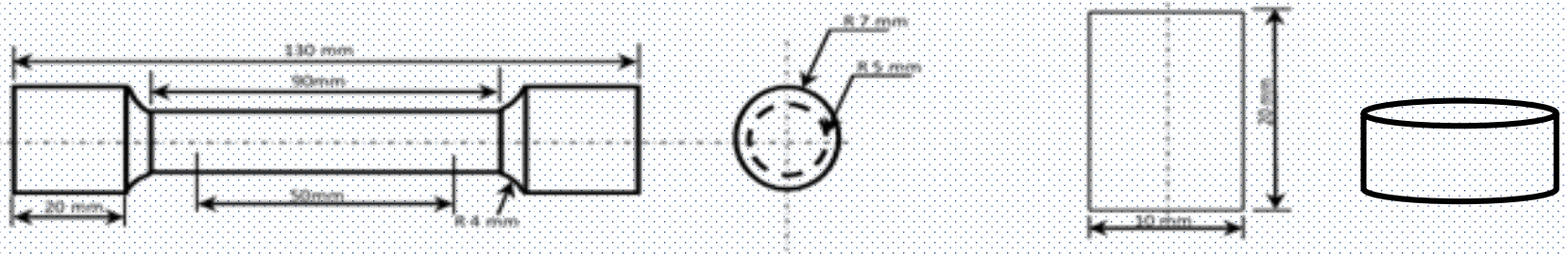


Dendritic Microstructure

Al magnesium-silicon Phase diagram

Results and Conclusion

Mechanical Properties



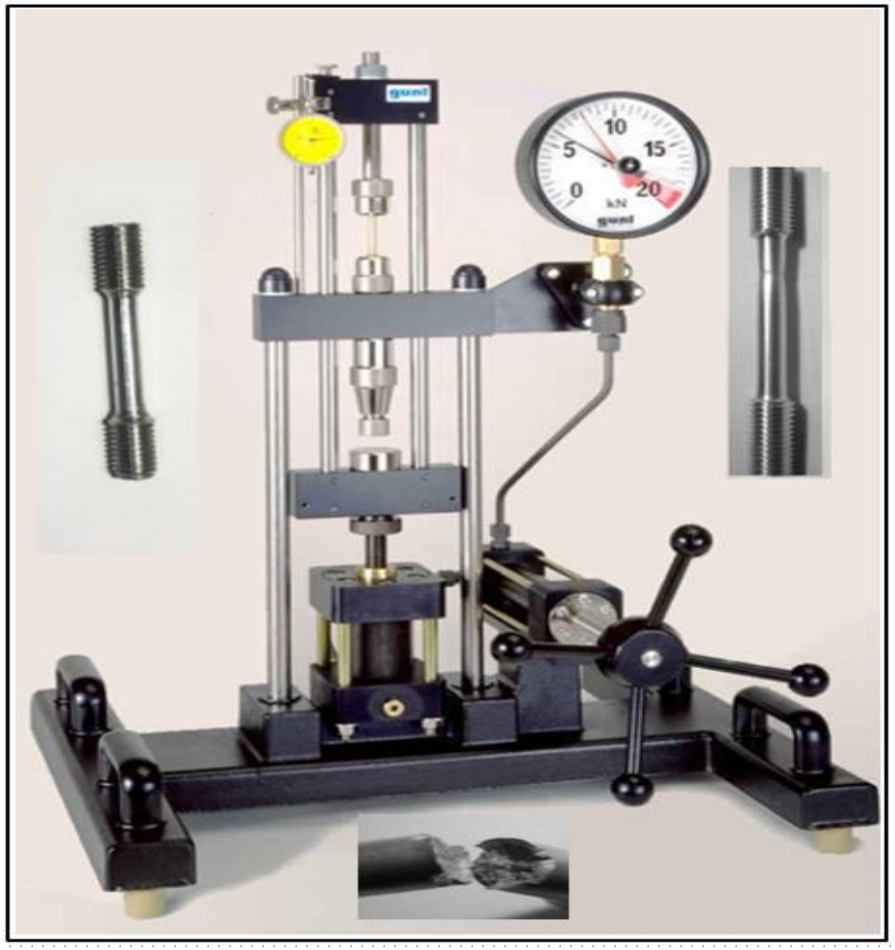
a b c

(a) samples of tensile test; (b) samples of compression test made and (c) samples of hardness test

Specimen for Tensile and Compression sample ASTM standard

Results and Conclusion

- **Tensile test**



Universal Testing Machine to the Tensile test before and after Rheocasting

ASTM standard

Results and Conclusion

- **Tensile test**

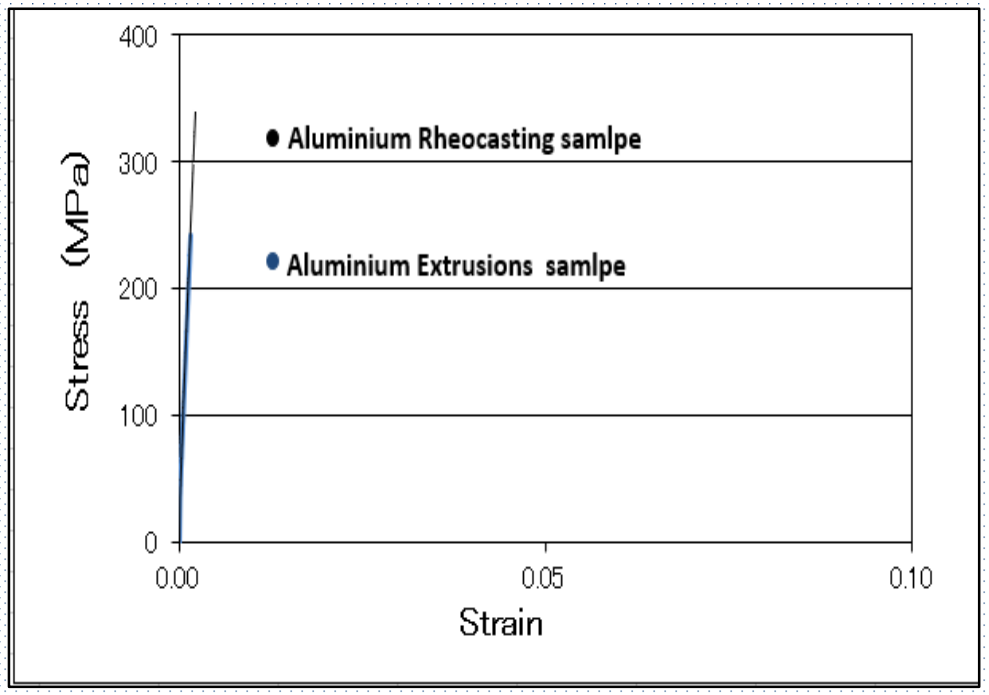
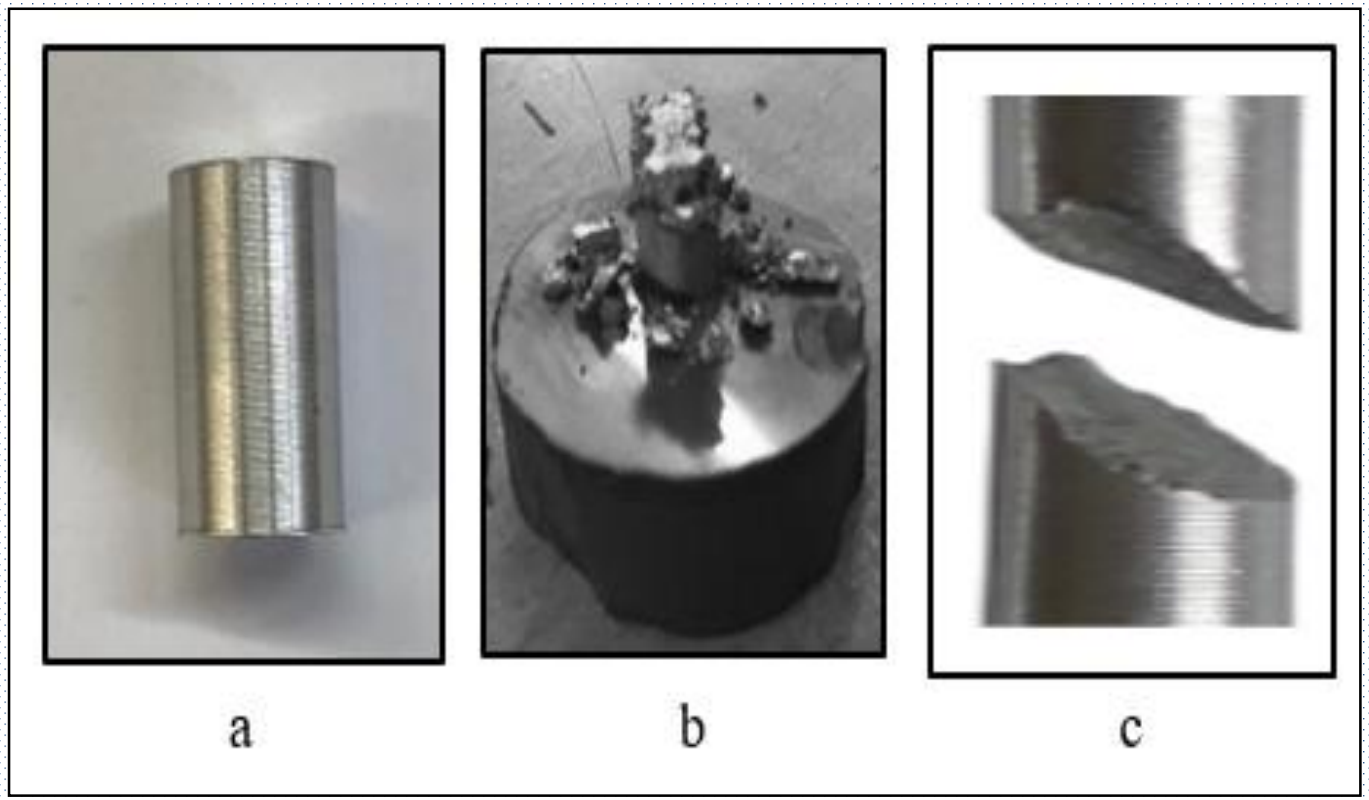


Figure 9. The Tensile of Aluminium EN6063-T6 Extrusions sample and Rheocasting sample curve

Aluminium alloy type	Yield Strength (σy) MPa	Ultimate Tensile Stress (UTS) MPa	% Strain
Aluminium Extrusions	215	241	0.0029
Aluminium Rheocasting	290	340	0.0032

Results and Conclusion

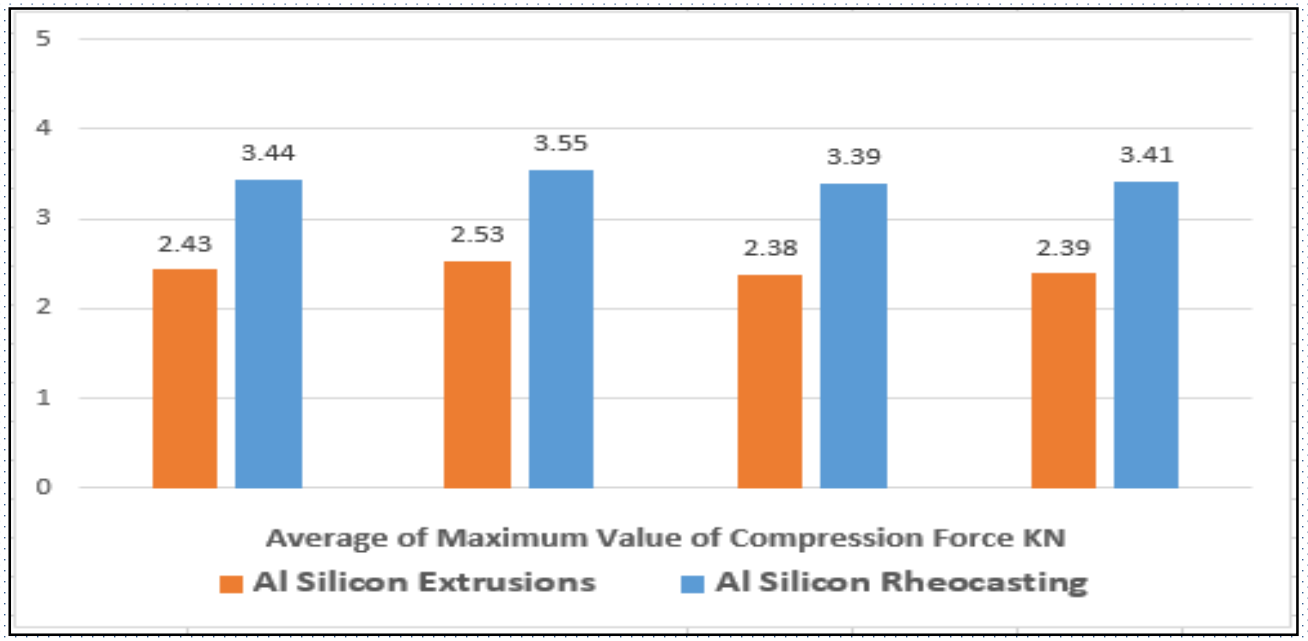
- **Compression Test**



a. The compression test specimen, b. Extrusions specimen and c. Rheocasting sample ASTM standard

Results and Conclusion

- **Compression Test**

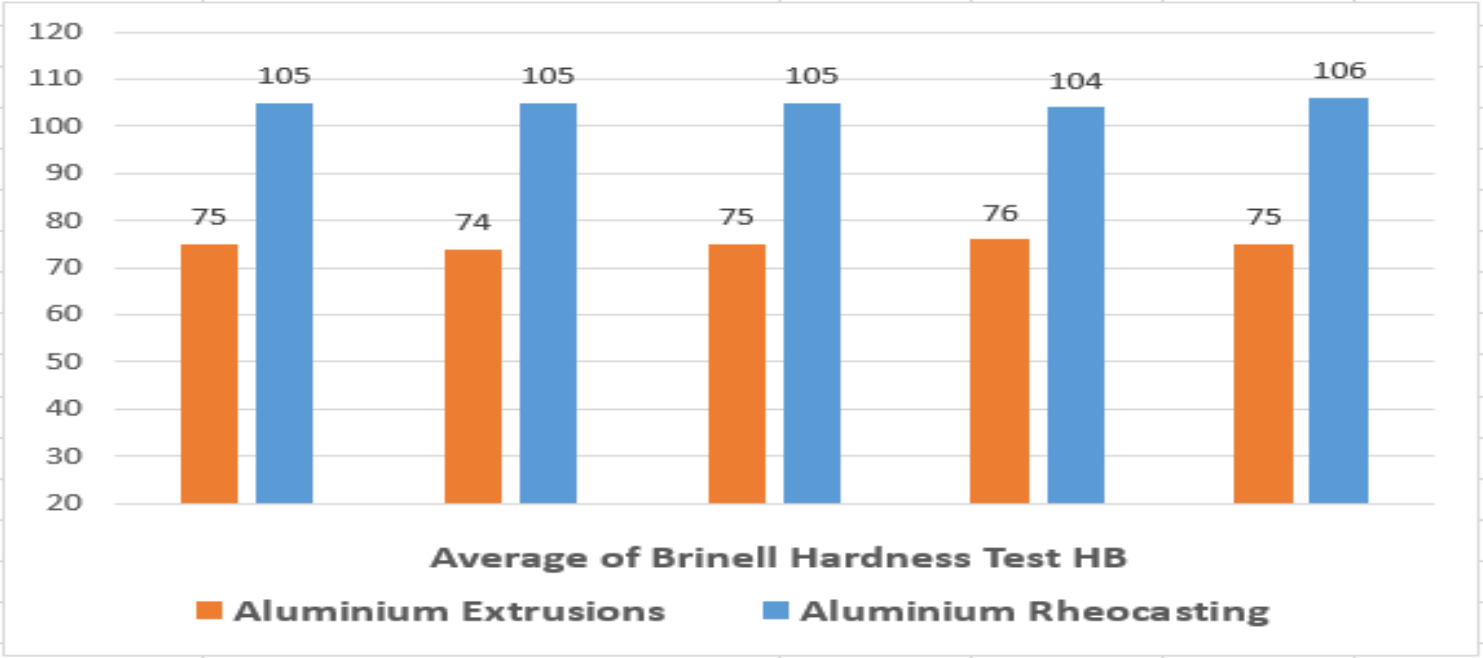


The Maximum Value of Rheocasting alloy and Extrusions alloy Compression Force

The average maximum force for Rheocasting sample was 3.44 KN when the average maximum force for Extrusions sample was 2.43 KN

Results and Conclusion

- **Brinell Hardness Test**



Hardness Brinell of Aluminium EN6063-T6 Extrusions and Rheocasting alloy

The average hardness Brinell results of Rheocasting sample **105** HB and Extrusions sample **75** HB.

Activity in all Semesters

- Publishing paper in International Engineering Symposium at Bánki (IESB 2017) the topic was: (**Comparison of the techniques to produce non-dendritic feedstocks for thixoforming**) (20.11.2017)

- Publishing paper in ***EUROPEAN JOURNAL OF MATERIALS SCIENCE AND ENGINEERING (2019)*** the topic was: (**COMPARISON BETWEEN THE Non-Dendritic Methods of an A201 Aluminum Alloy Depending on Mechanical Properties and Microstructure**) in (02.10.2019)

- Finishing work on paper (**Mechanical Properties of Aluminium EN 6063 - T6 Extrusions alloy and Semi-Solid Rheocasting Alloy)**

- Teaching activity the Subject was **Material Science.**

- **Laboratories Work.**

Future Research Plan

My Future Study will be about behavior another aluminum alloy (6xxx) in deferent Temperature.
Work will be about mechanical properties focusing in **Impact toughness** .

Thanks for your attention!