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

Testing in Semi-Solid State

by

Kawan M. Abdulrahman

PhD Student

kawan.abdulrahman@bgk.uni-obuda.hu

Supervisors by :

Dr. Viktor Gonda and Dr.Réger Mihály

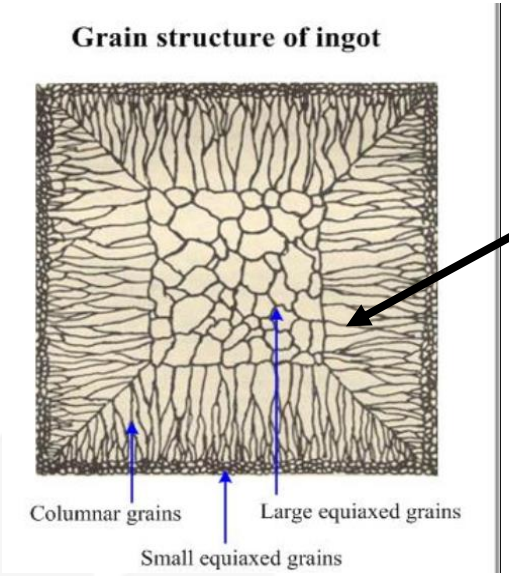
24/06/2020

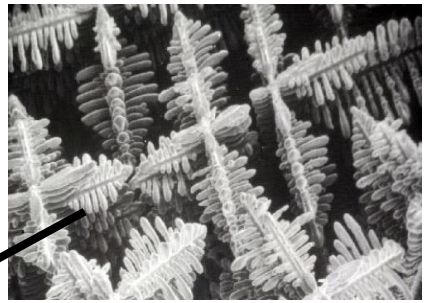
Outline

- ✓ 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

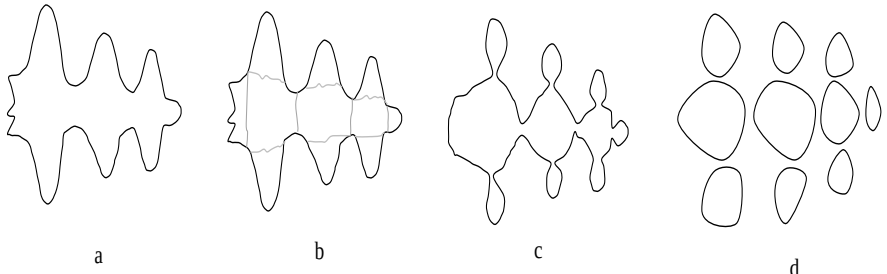
What is dendritic structure?





Dendritic structure of material

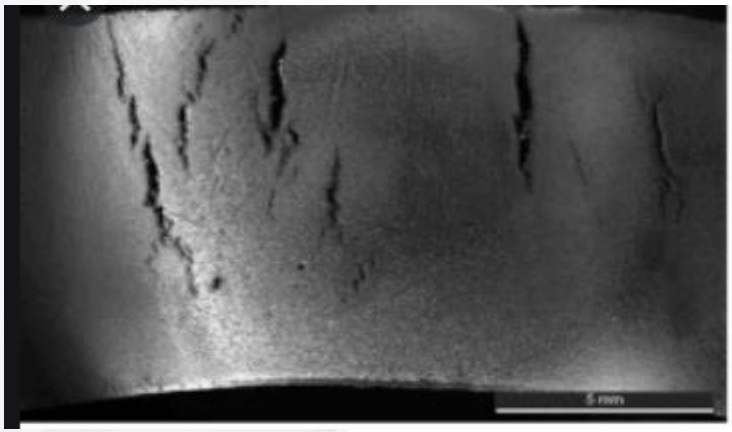
Microstructural changes



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



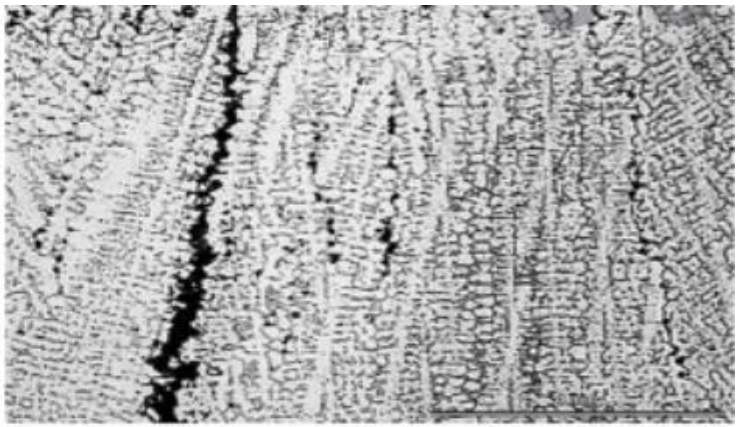


Figure 1. Failure Arm Dendritic structure

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 (CS)
4. SSR with CS techniques (SS + CS)

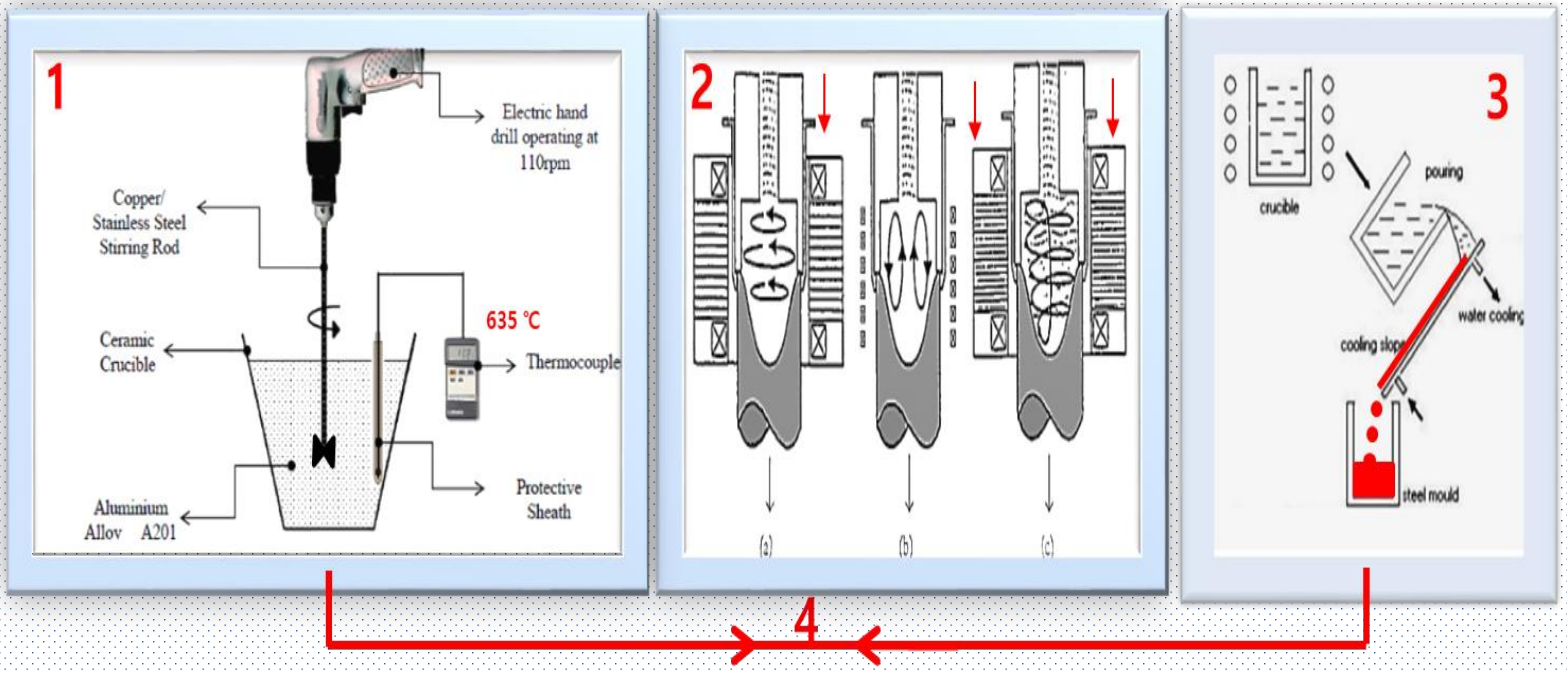


Figure 2. Semi - Solid Methods

Previous work

Microstructure Results

Aluminium A210 alloy

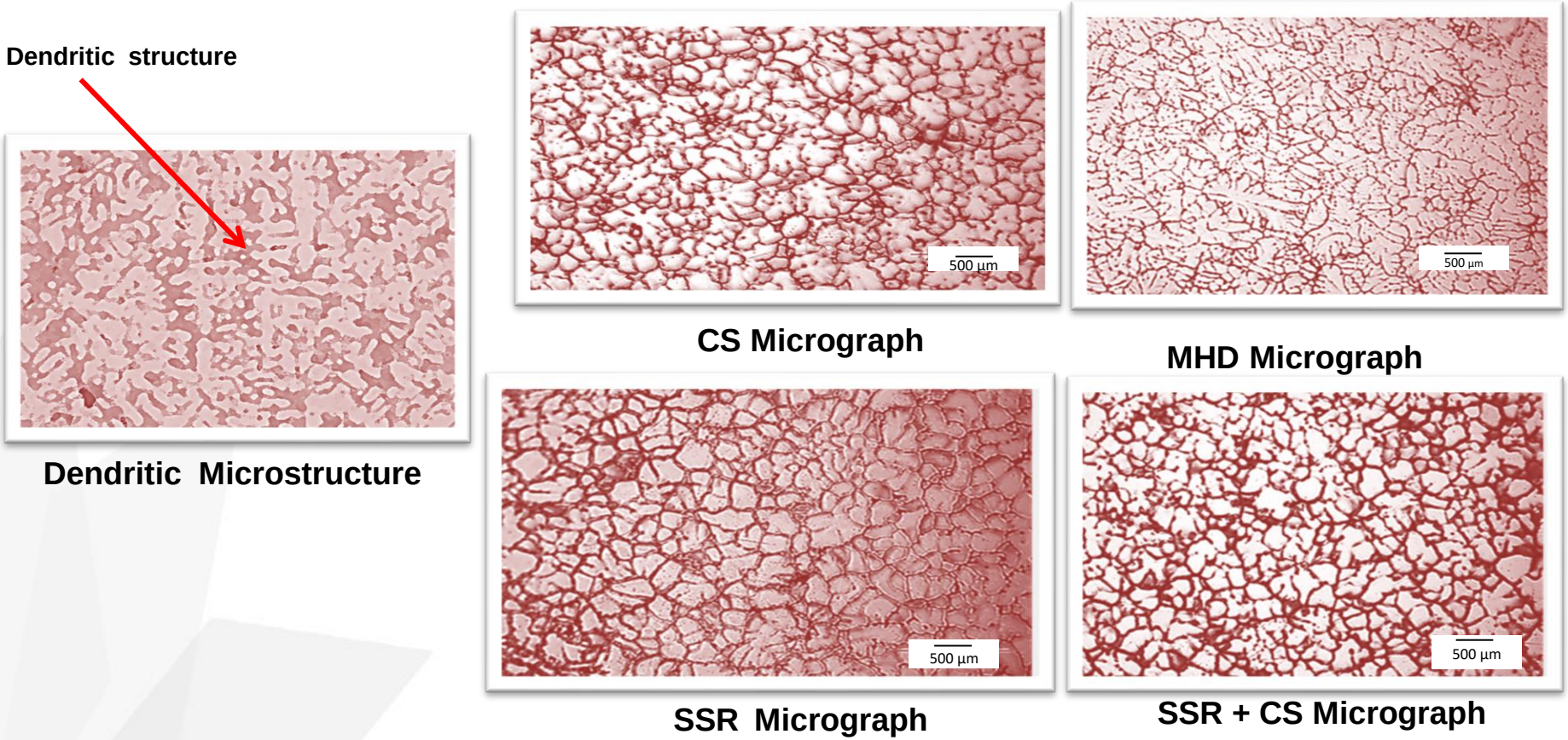
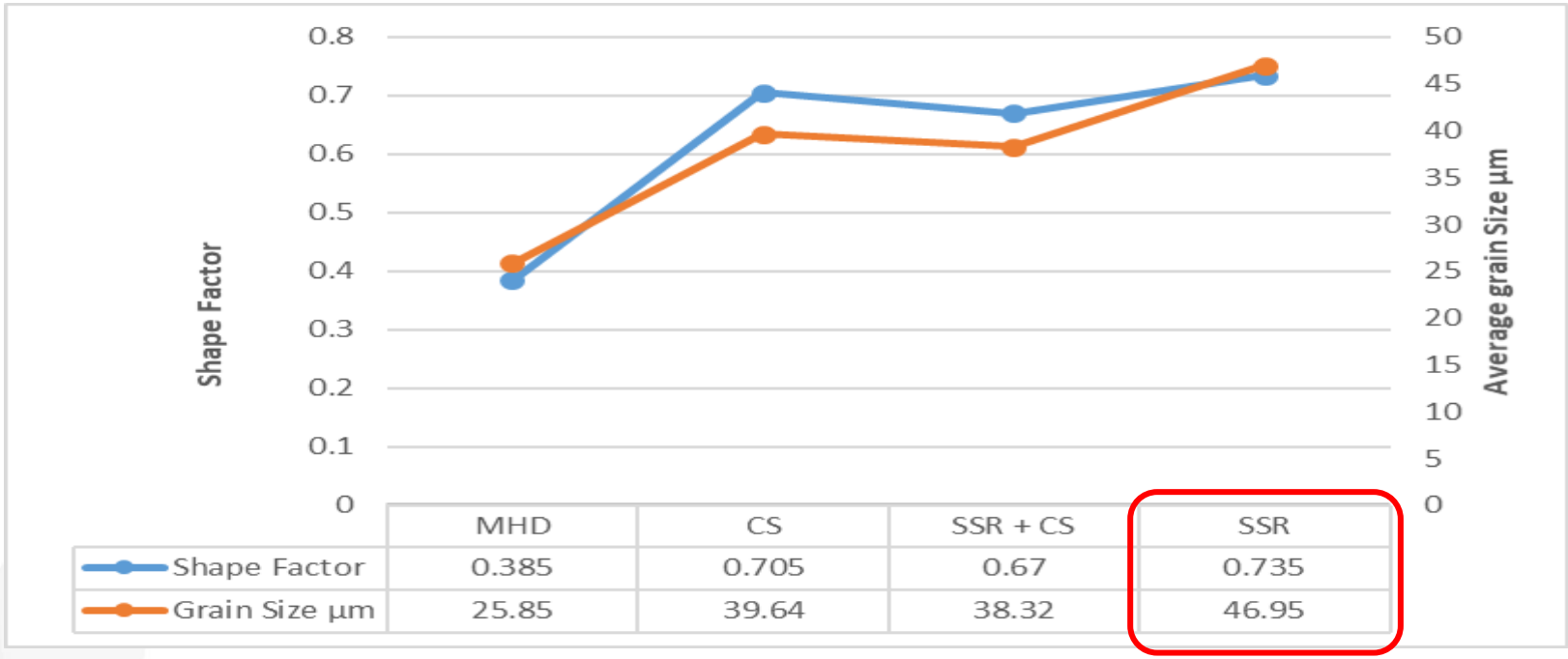


Figure 3. Microstructure of all Semi - Solid Methods

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

Figure 4. 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

Aluminium EN6063-T6 Extrusions alloy

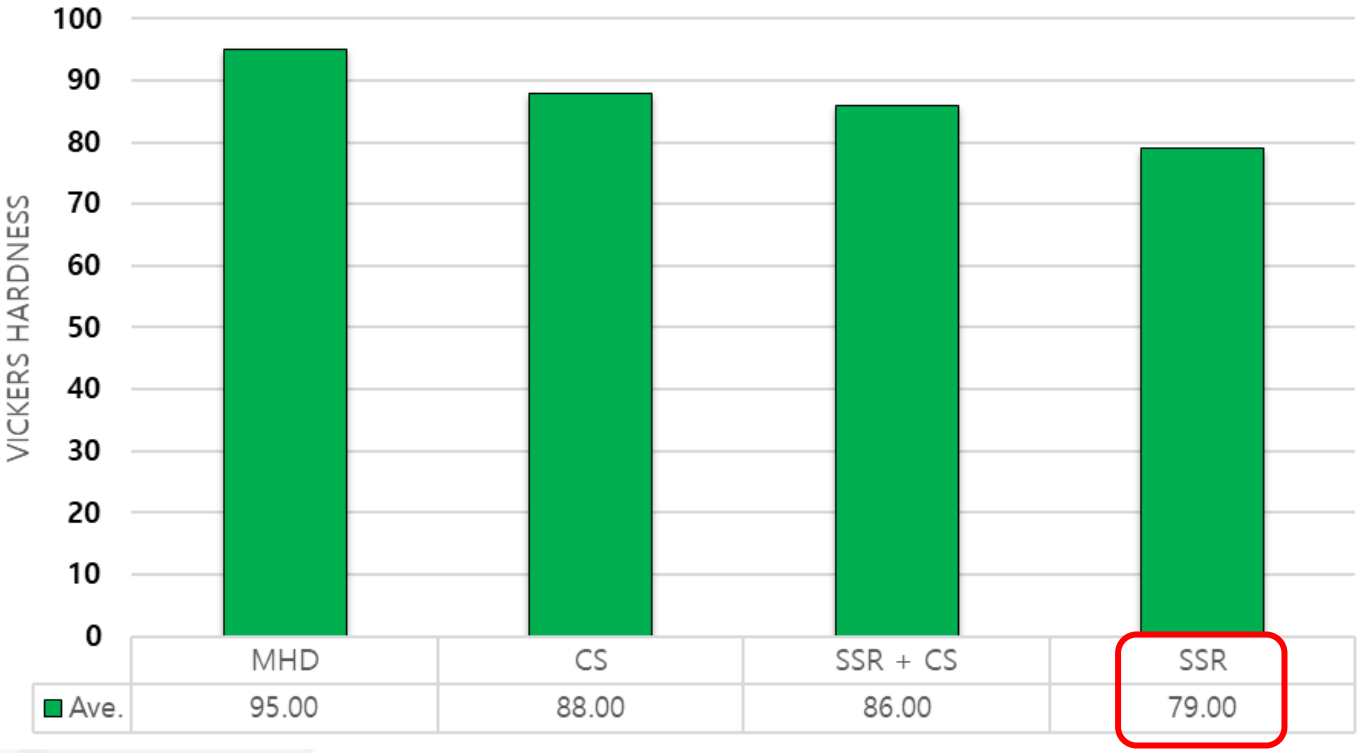


Figure 5. Vickers Hardness of all Methods

Previous work

- **Tensile test**

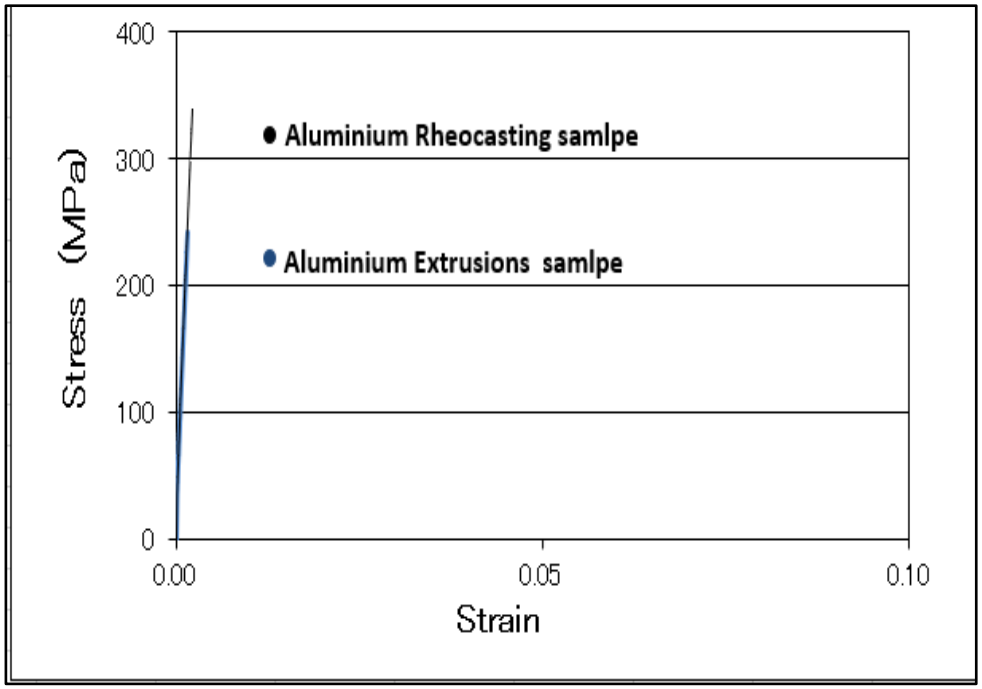


Figure 6. The Tensile of Aluminium EN 6063-T6 Extrusions sample and Rheocasting sample curve

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

Previous work

- **Compression Test**

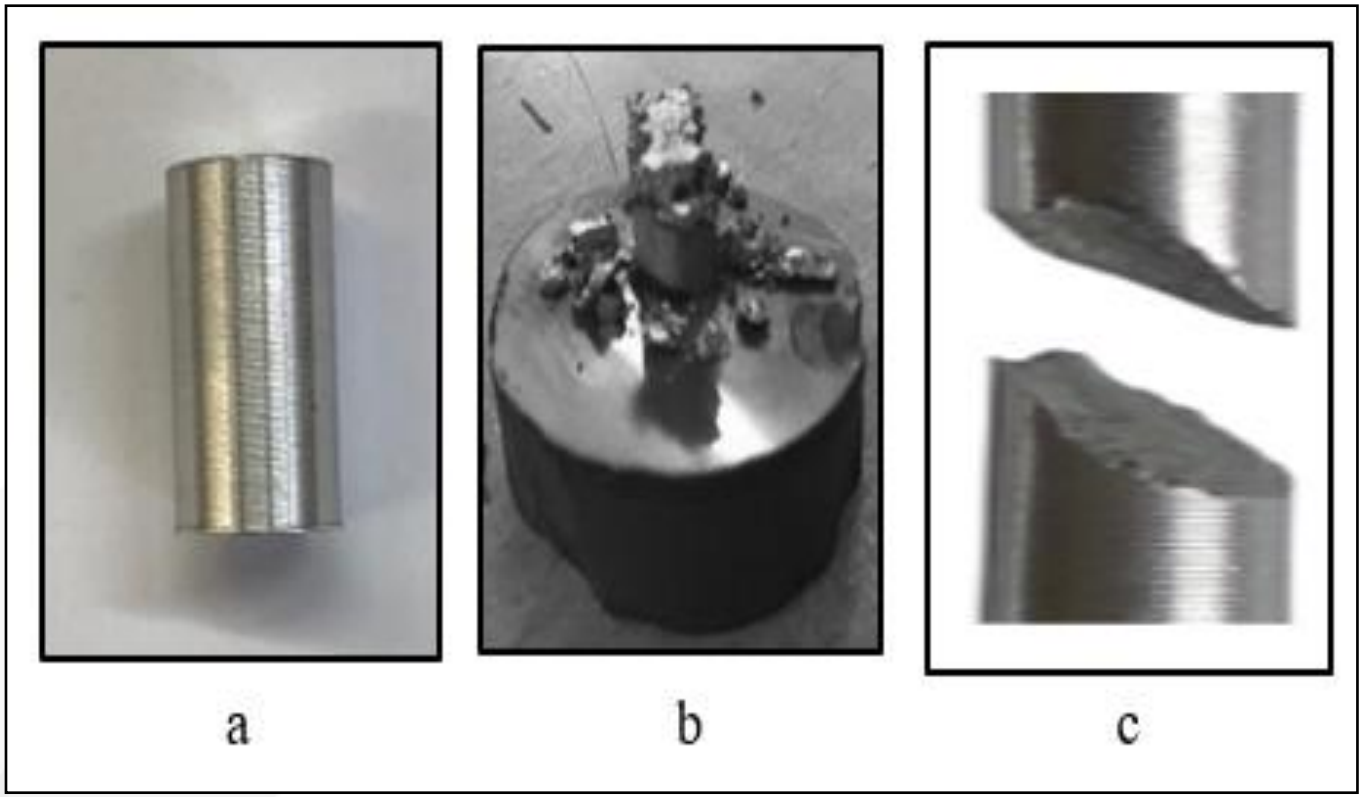


Figure 7. a. The compression test specimen, b. Extrusions specimen and c. Rheocasting sample ASTM standard

Previous work

- **Compression Test**

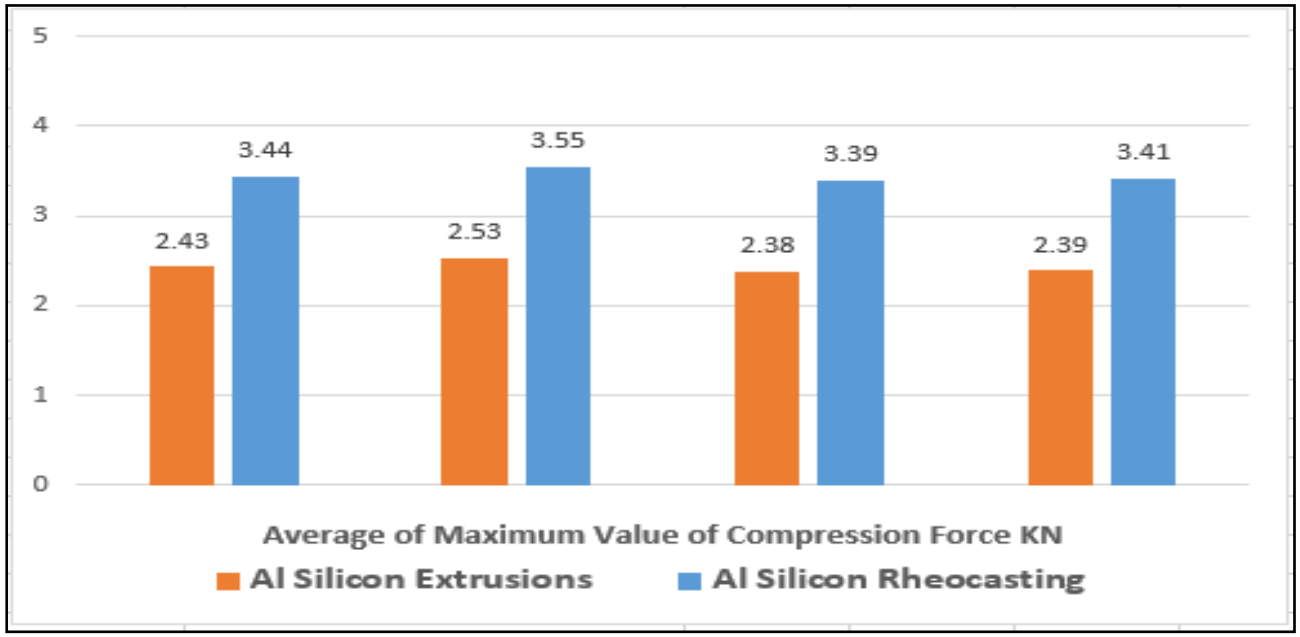


Figure 8. The Maximum Value of Rheocasting alloy and Extrusions alloy Compression Force

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

Previous work

- **Brinell Hardness Test**

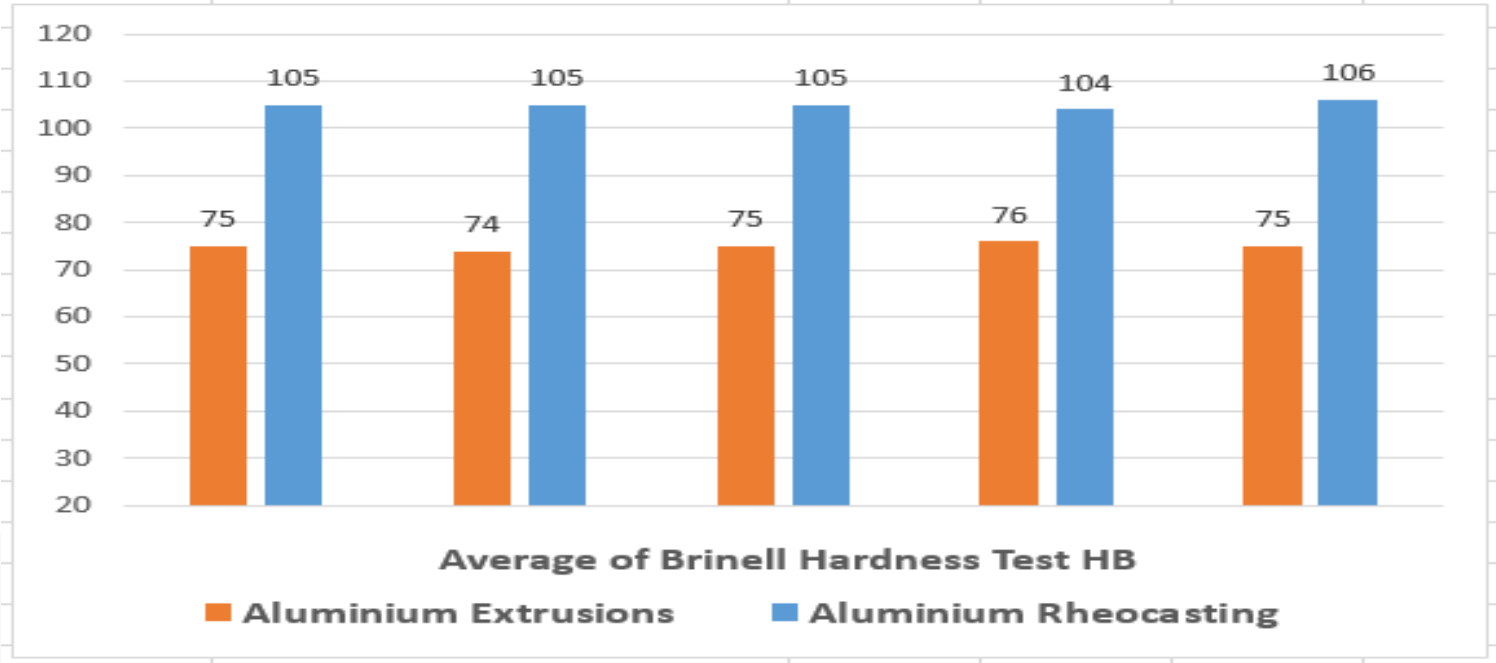


Figure 9. Hardness Brinell of Aluminium EN6063-T6 Extrusions and Rheocasting alloy

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

Aluminum Alloy

Improvement of Impact toughness Properties for the Rheocasting aluminium alloy EN AW 6082 And Casting aluminium alloy EN AW 6082 In different temperatures

Aluminium EN AW 6082 -T6 alloy

Source (wt%)	Al	Si	Mg	Cr	Fe	Mn	Cu	Zn	Ti
EN6063-T6	Bal.	0.6	0.7	0.25	0.3	0.4	0.1	0.2	0.1

Major alloying

Advantages:

- Medium mechanical properties, medium strength
- Good formability in the temper T4,
- Most generally used for machining
- Excellent corrosion resistance

Application:

- Rail coach parts,
- Offshore constructions
- Machine building and mobile cranes.

The SSR Feedstocks

the mold for the impact the samples

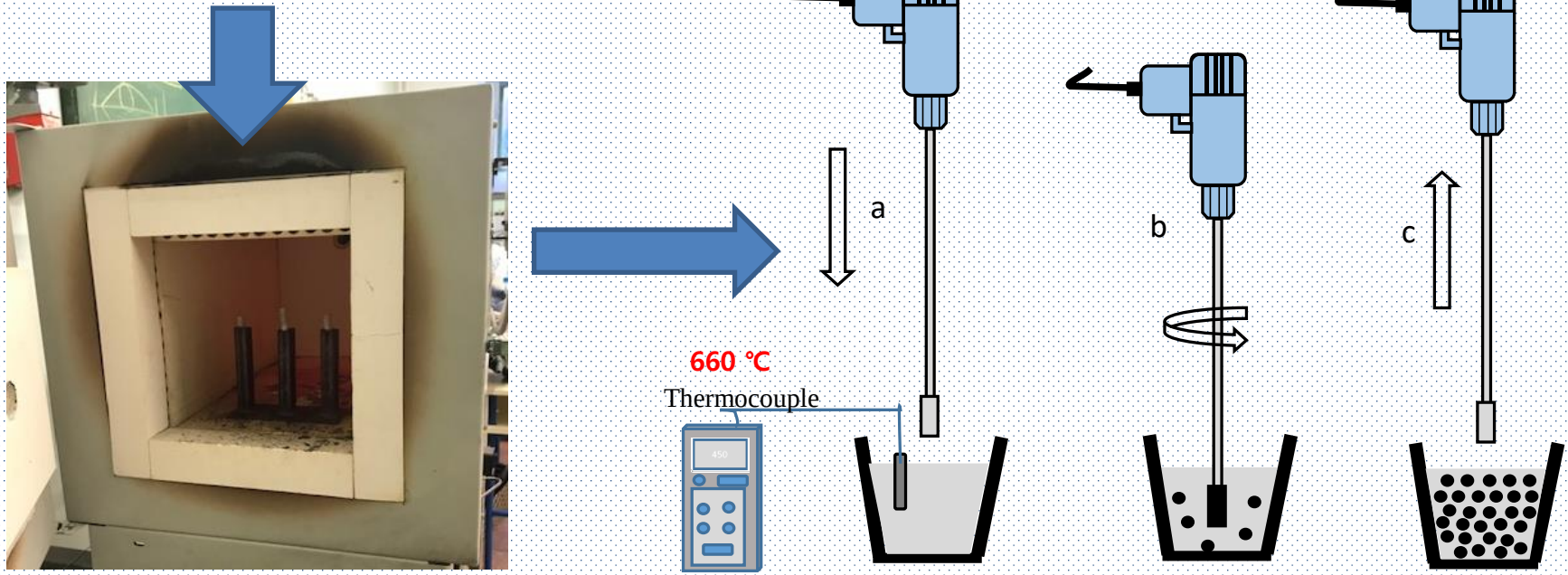


Figure 10. Rheocasting process active in the present work: (a) solid block of the same alloy prepared in advance, attached to a stainless steel rod, (b) dissolved in the melt with simultaneous stirring action, and (c) the slurry thus produced.

How can get Semi - Solid State?

Semi-Solid Process Window

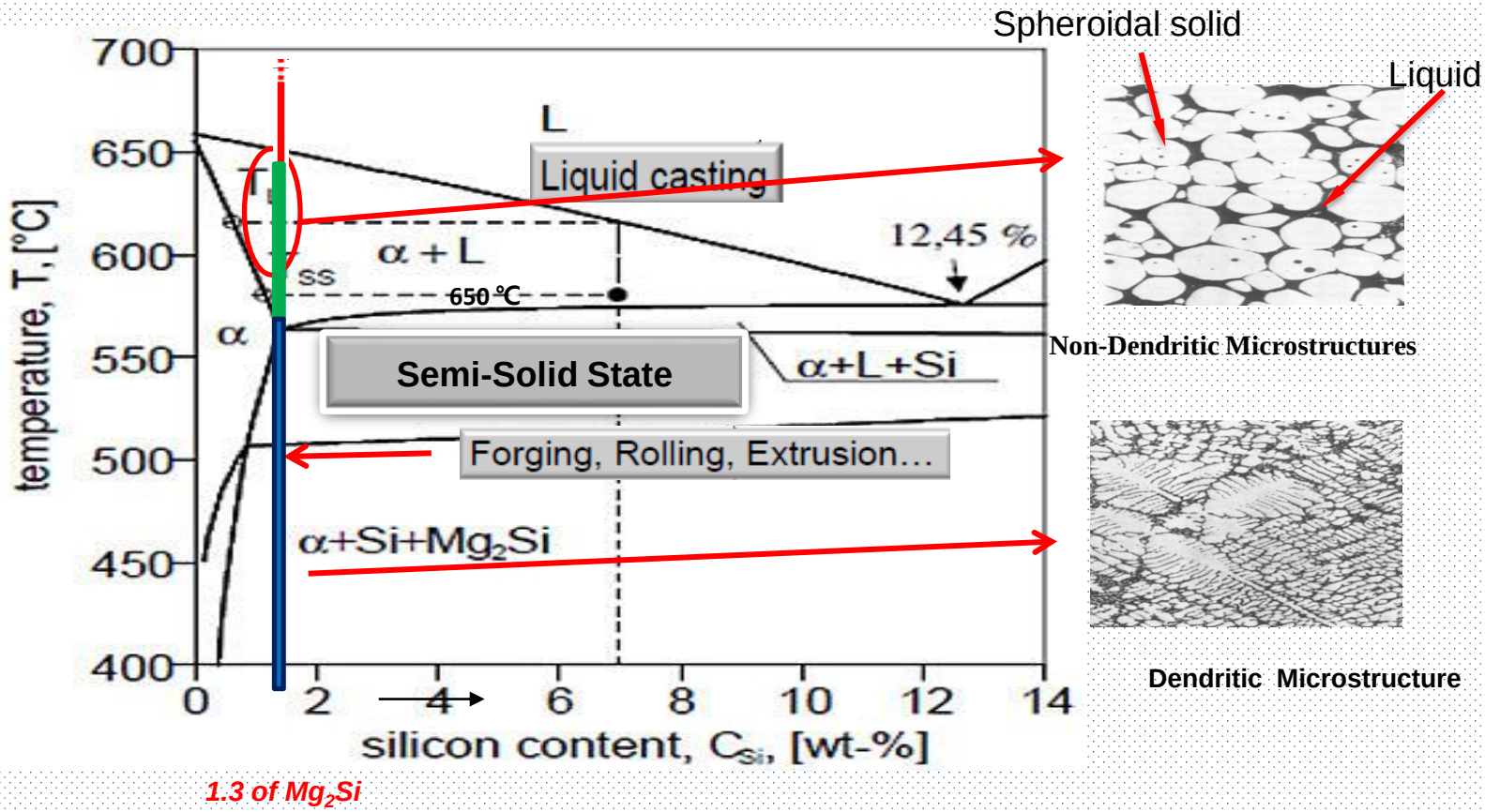


Figure 11. Al magnesium-silicon Phase diagram

Results and Conclusion

Mechanical Properties

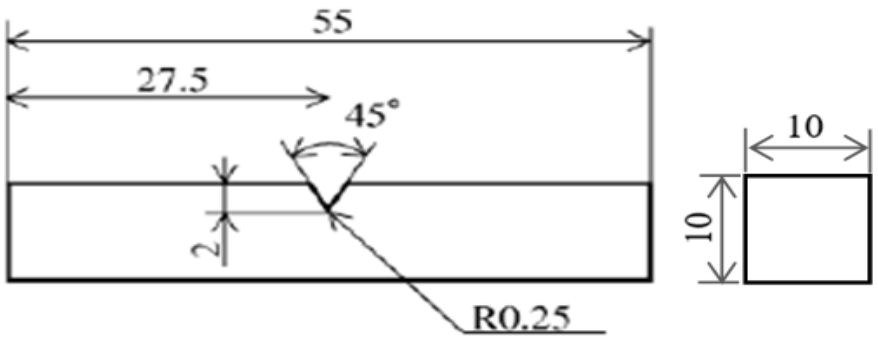


Figure 12. standard dimension of chrpy impact test sample

Figure 13. chrpy test impact sample

Results and Conclusion

- **Impact test**

Figure 14. ACS Compact Test Chambers

Results and Conclusion

- **Impact test**

Figure 15. Impact test VEB machine

Rheocasting sample

casting sample

Results and Conclusion

- **Impact test**

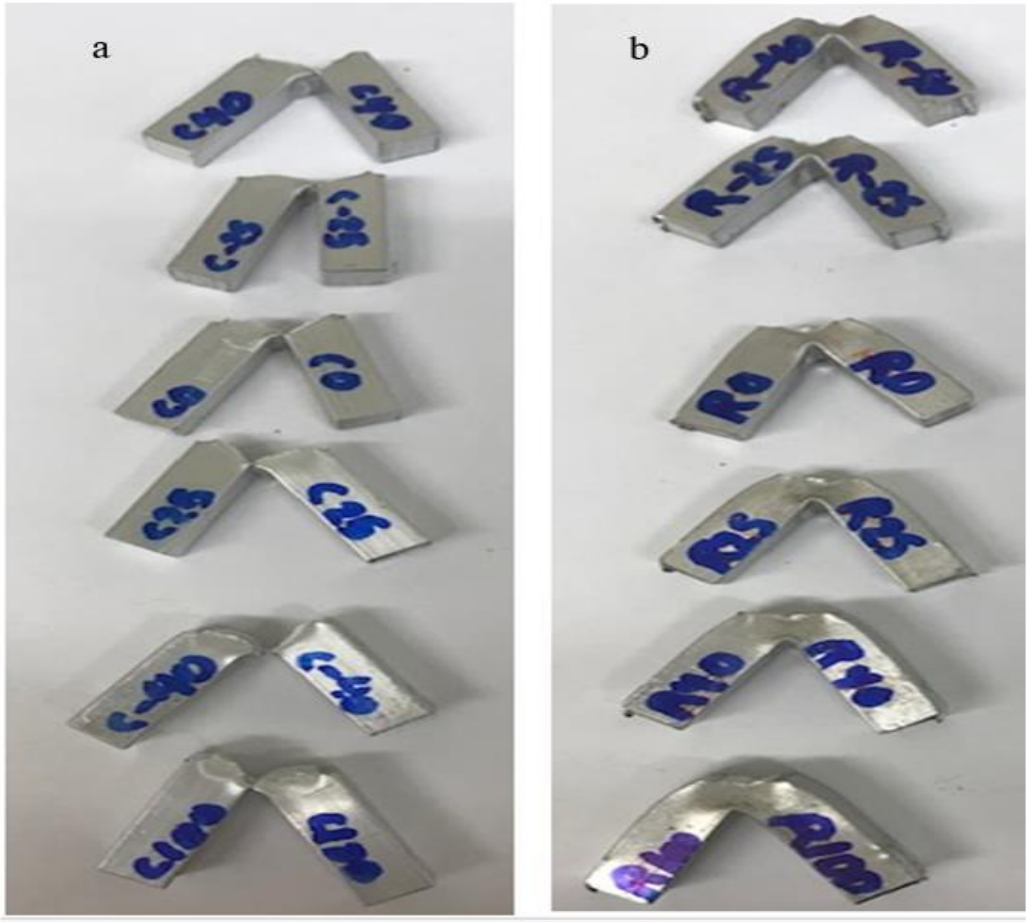
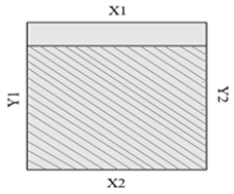


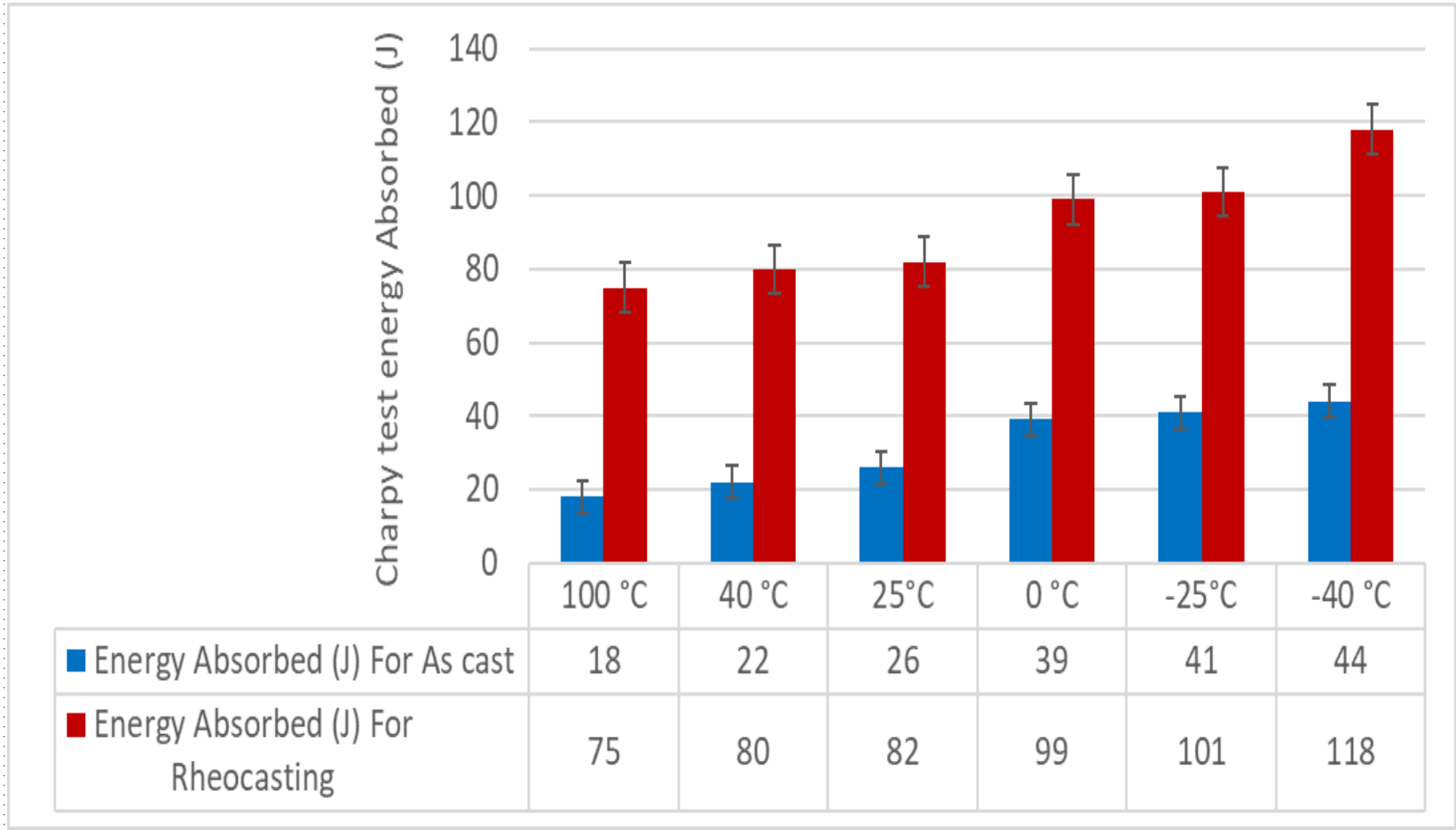
Figure 16. Charpy Impact test samples a. casting samples b. rheocasting samples



standard cross-section area of Charpy impact test

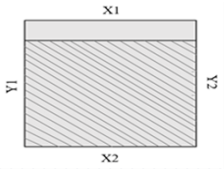
Results and Conclusion

- **Impact test**



	100 °C	40 °C	25°C	0 °C	-25°C	-40 °C
Energy Absorbed (J) For As cast	18	22	26	39	41	44
Energy Absorbed (J) For Rheocasting	75	80	82	99	101	118

Figure 17. the values energy absorbed in casting and rheocasting samples



standard cross-section area of Charpy impact test

Results and Conclusion

- **Impact test**

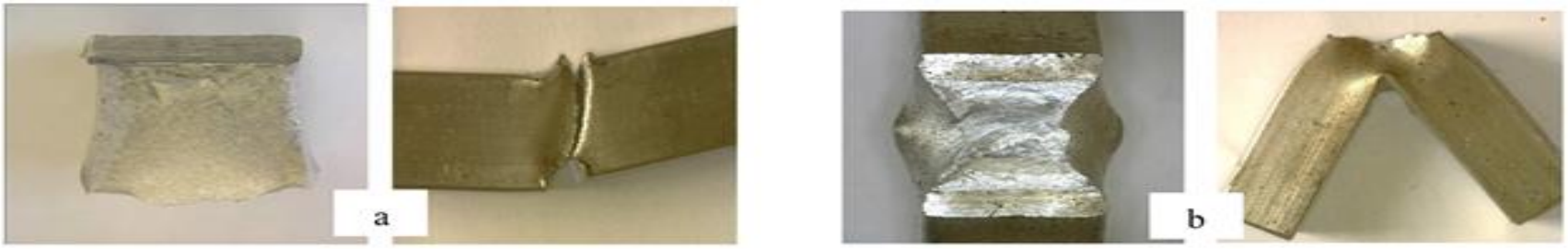


Figure (13) a. Front and side view of as-cast Specimen in 0°C, b. Front and side view of rheocasting Specimen in 0°C

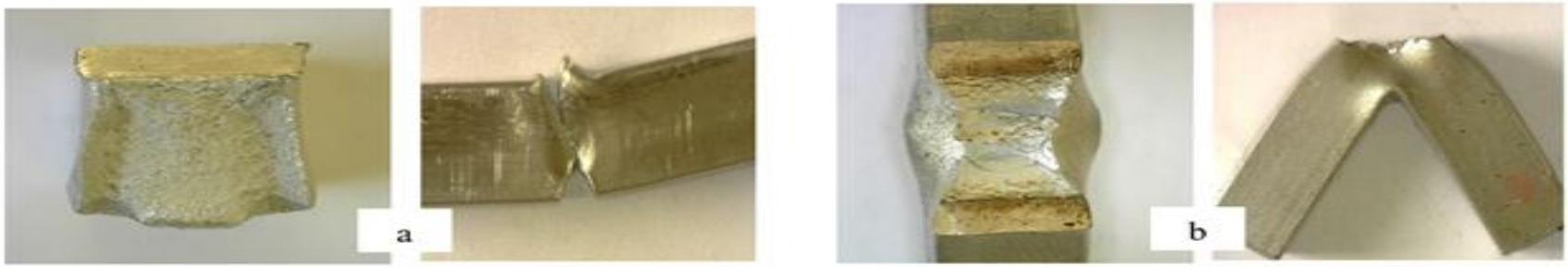
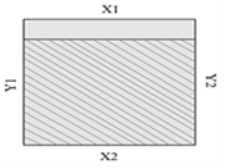


Figure (14) a. Front and side view of as-cast Specimen in 25 °C, b. Front and side view of rheocasting Specimen in 25°C

Figure (15) a. Front and side view of as-cast Specimen in 40 °C, b. Front and side view of rheocasting Specimen in 40°C

Figure 18. Measuring the effect Charpy Impact Test in the samples

Results and Conclusion



standard cross-section area of Charpy impact test

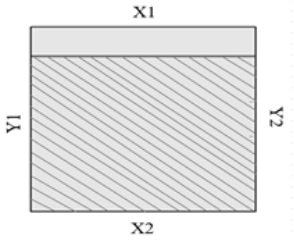
- **Impact test**

Figure (16) a. Front and side view of as-cast Specimen in 100 °C, b. Front and side view of rheocasting Specimen in 100°C

Figure (17) a. Front and side view of as-cast Specimen in -25 °C, b. Front and side view of rheocasting Specimen in -25°C

Figure (18) a. Front and side view of as-cast Specimen in -40 °C, b. Front and side view of rheocasting Specimen in -40°C

Figure 19. Measuring the effect Charpy Impact Test in the samples



Results and Conclusion

- **Impact test**

standard cross-section area of Charpy impact test

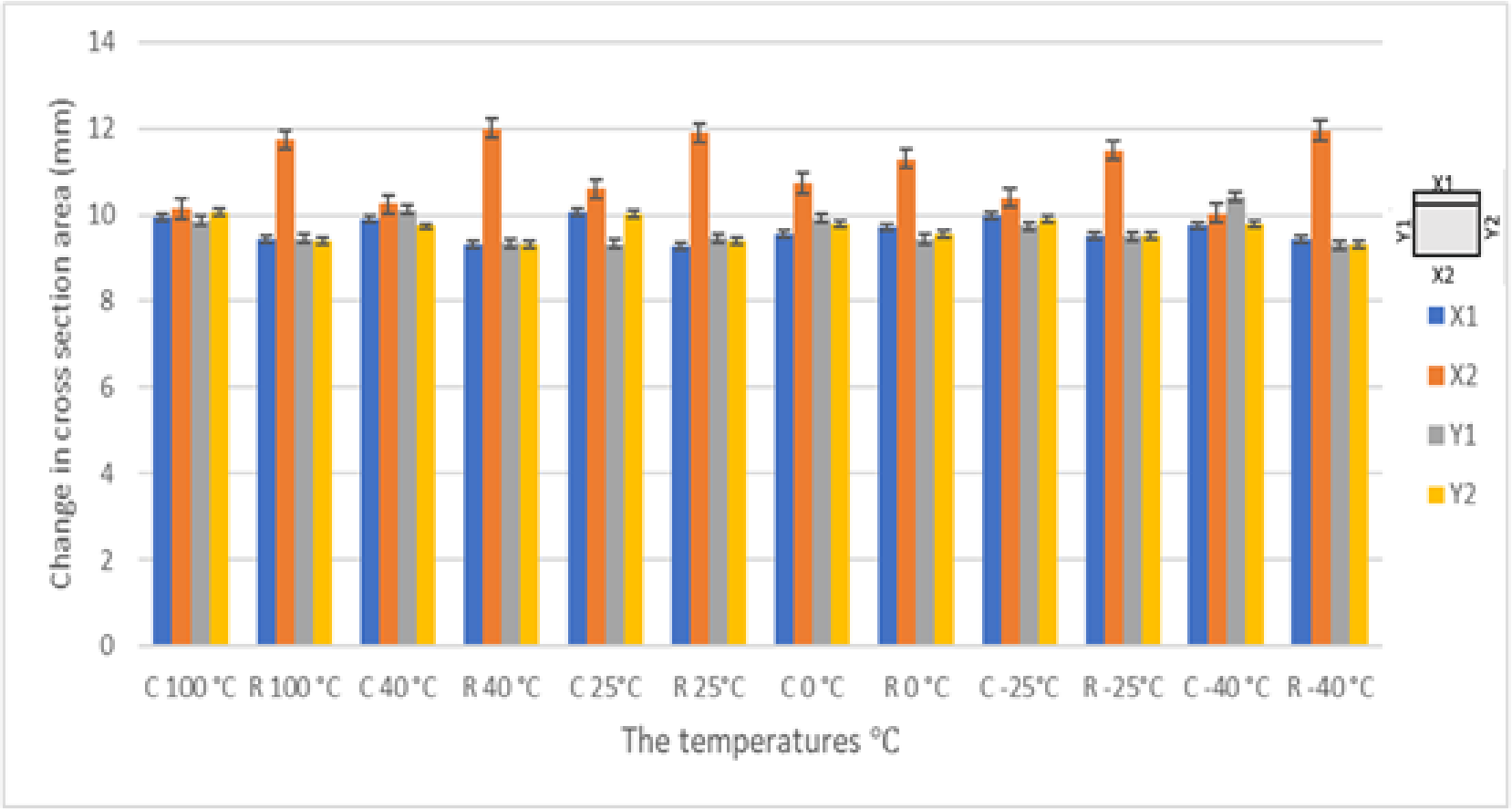


Figure 20. Calculate explosive edge in the Charpy Impact Test

Results and Conclusion

- **Hardness test**

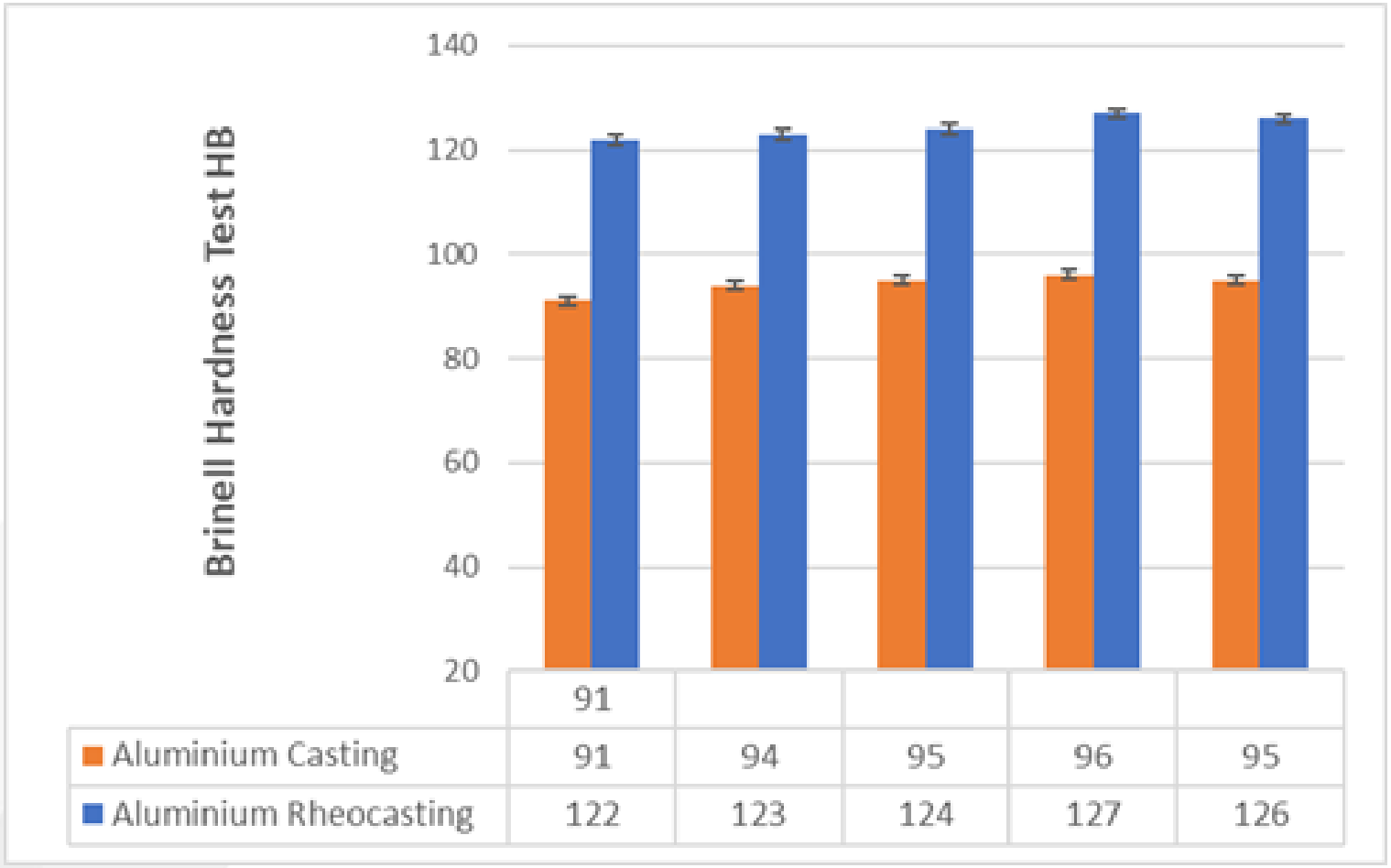


Figure 21. Average hardness Brinell of Aluminium EN AW 6082 and Rheocasting alloy

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)

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

- Finishing work on paper **(Improvement of Impact toughness Properties for the Rheocasting aluminium alloy EN AW 6082 And Casting aluminium alloy EN AW 6082 In different temperatures**)

Future Research Plan

- **Plane to publishing the two finishing paper .**
- **Start work in my thesis.**

Thanks for your attention!