



11-13 May 2026 - Milan, Italy

Experimental Assessment of Granulated EAF Slag for blasting operations as sand substitute in steel production

Edoardo D'Amanzo – Rina Consulting - Centro Sviluppo Materiali



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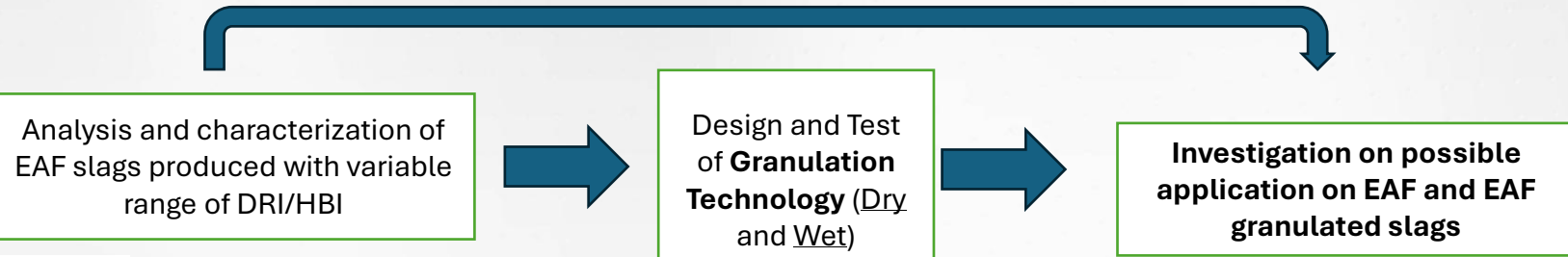
Agenda

- Introduction to InSGeP project
- Granulation process description
- EAF Granulated Slag Characterization
- Adopted methodology for abrasive behavior of EAF granulated slag
- Post – test characterizations
- Conclusions

Overview of InSGeP Project

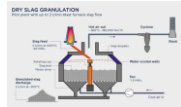
The present study is part of the activities carried out in the on-going RFCF co-funded project **InSGeP (Investigations of Slags from Next Generation Steel Making Processes)**.

Project Info
 Start Date: July 2023
 End Date: June 2027
 Coordinator: FEHS institute



EAF Slag

Slag A	4% of DRI
Slag B	20% of DRI
Slag C	90% DRI
Slag D	40% DRI – 60 % Hot metal
....	



InSGeP



Overview of InSGeP Project



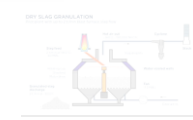
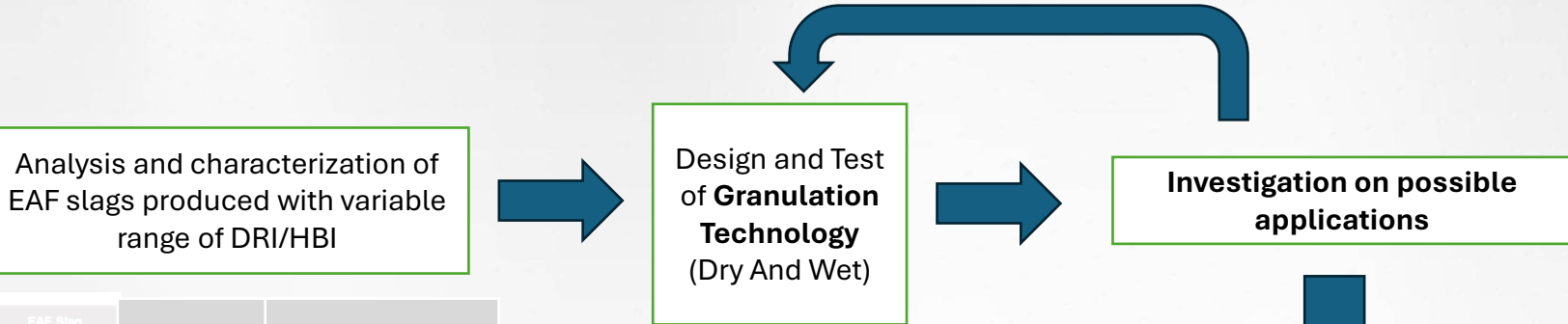
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Iterative Loop



The research leading to these results has received co-funding from the European Union's Research Fund for Coal and Steel research programme under grant agreement number: 101112665

Overview of InSGeP Project

The present study is part of the activities carried out in the on-going RFCF co-funded project **InSGeP (Investigations of Slags from Next Generation Steel Making Processes)**.

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Analysis and characterization of EAF slags produced with variable range of DRI/HBI

Design and Test of **Granulation Technology** (Dry And Wet)

Investigation on possible applications

road construction

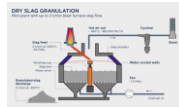
cement/concrete

Blast Sand

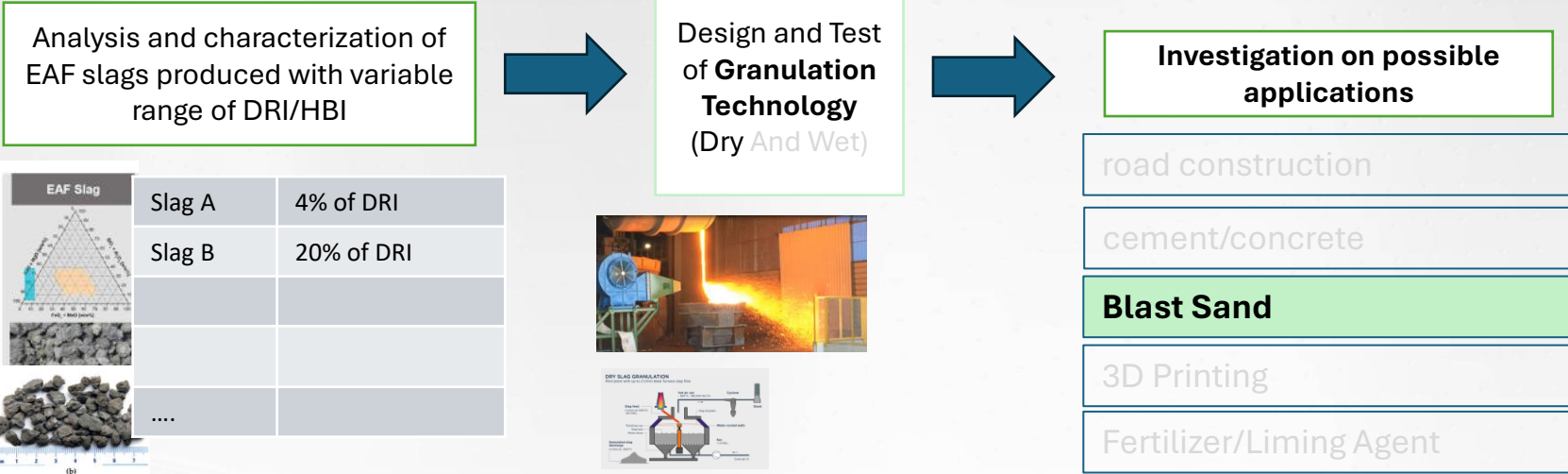
3D Printing

Fertilizer/Liming Agent

EAF Slag	Composition
Slag A	4% of DRI
Slag B	20% of DRI
Slag C	90% DRI
Slag D	40% DRI – 60 % Hot metal
....	



Description of current study



The present study focus on one application of EAF granulated slag as substitute for blast Sand.

Main Reasons:

- Presence of FeO makes slag dense and heavy
- Dry granulation stabilize the shape and chemistry

Blasting Sand Operation – general overview

The use of sand for descaling operation is quite common in industry, in particular steel industry.

The process consists in promoting the impact of a hard material on metal surface:

- Abrasion
- Descaling
- Polishing
- Shot Peening

The abrasive media commonly used are corundum, garnet, high carbon steel, ecc.

The general rule is that the hardness of abrasive media must be superior to hardness of metal surface

Scope of the work and methodology

- Scope of the work is to compare the **behaviors of 2 granulated slags** with a reference material as abrasive media on a steel specimens.

Methodology

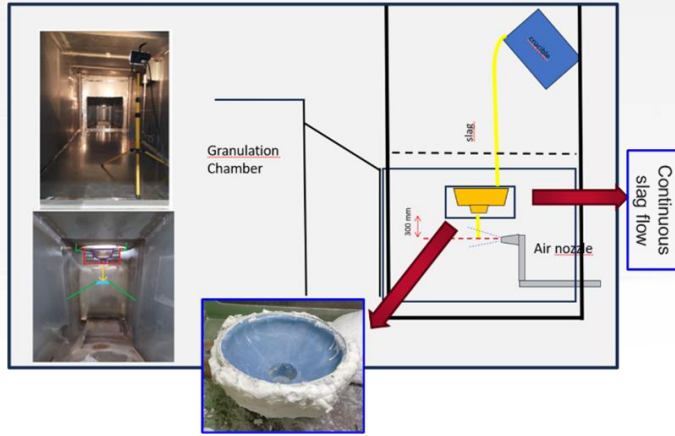
- Production of 2 samples of EAF granulated slags
- Characterization of slag samples
- Slurry Tests in Comparison with Corundum in accordance to Standard GT75-07
- Post test characterization on slag and steel samples

Preliminary consideration – how granulated slag is produced

Granulated slag is produced in pilot plant in Rina CSM, based on the indication of TENOVA that is the technology provider.

Parameter for granulation:

- Air Flowrate
- Nozzle geometry



EAF Granulated Slag Characterization



The following analysis have been analyzed preliminary of granulated slag samples (Slag A and Slag B):

- Chemical Composition
- XRD analysis
- Leaching Test
- SEM Analysis
- Granulation Curves
- Determination of Qualitely Hardness Index



EAF Granulated Slag Characterization

The following analysis have been analyzed preliminary of granulated slag samples (Slag A and Slag B):

- Chemical Composition

	Slag A	Slag B
MgO	4.11	4.81
Al₂O₃	23.61	28.71
SiO₂	6.93	5.15
CaO	16.51	20.85
TiO₂	0.4	0.23
V₂O₅	0.26	0.24
Cr₂O₃	0.42	0.93
MnO	3.18	4.53
FeO	38.86	29.82

Different Slag Origin

EAF Granulated Slag Characterization

The following analysis have been analyzed preliminary of granulated slag samples (Slag A and Slag B):

- XRD Diffraction

Both Slag presents relevant amount of glassy fraction with Slag B > Slag A.

Corundum is 100% crystalline

EAF Granulated Slag Characterization

The following analysis have been analyzed preliminary of granulated slag samples (Slag A and Slag B):

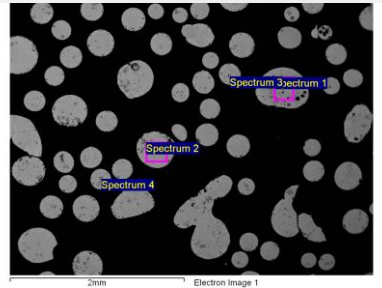
- Leaching Test (1:2 and 1:10) . Slag range within limits

EAF Granulated Slag Characterization

The following analysis have been analyzed preliminary of granulated slag samples (Slag A and Slag B):

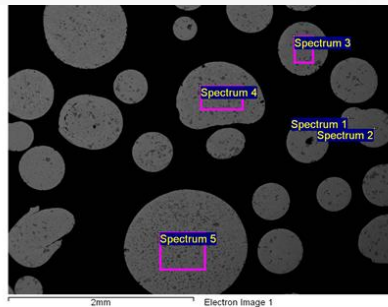
- SEM Analysis: Spherical form, sub particles with high concentration of Al₂O₃ and spinel phases

Slag A



Sp	O	Mg	Al	Si	P	Ca	Cr	Mn	Fe
1	21.33	2.38	12.98	5.06	0.31	17.76		2.54	37.64
2	19.69	2.17	13.77	4.77		16.56		2.82	40.21
3	17.37	0.92	11.46	6.82		21.23		3.29	38.91
4	19.98	5.16	19.86	1.54		5.22	0.86	3.76	43.62

Slag B

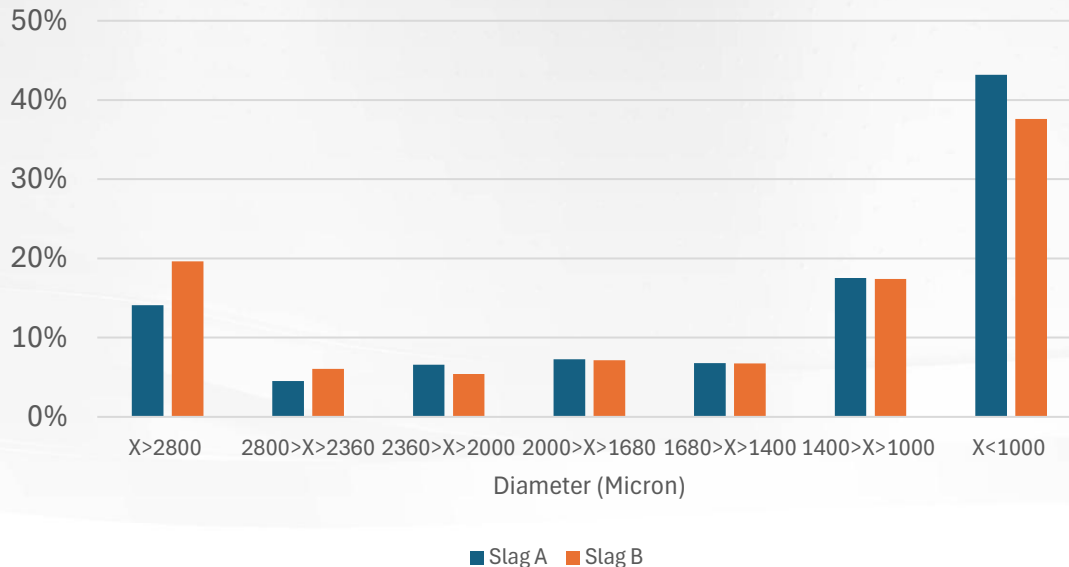


Sp	O	Mg	Al	Si	Ca	Cr	Mn	Fe
1	22.51	10.41	31.65	0.49	2.72	10.42	3.13	18.66
2	18.68	2.51	16.22	3.33	24.02		5.25	29.99
3	22.06	3.34	18.08	2.92	19.52	0.74	4.42	28.93
4	20.42	3.56	17.46	3.36	19.72	0.78	4.70	30.00
5	19.39	3.28	17.58	3.61	21.28	0.81	3.91	30.14

EAF Granulated Slag Characterization

The following analysis have been analyzed preliminary of granulated slag samples (Slag A and Slag B):

- Granulation Curves



Distribution is similar.

In Slag A the fraction below 1000 micron is little higher.

For Slurry test the Selected Fraction is 1.68 – 0.5 mm

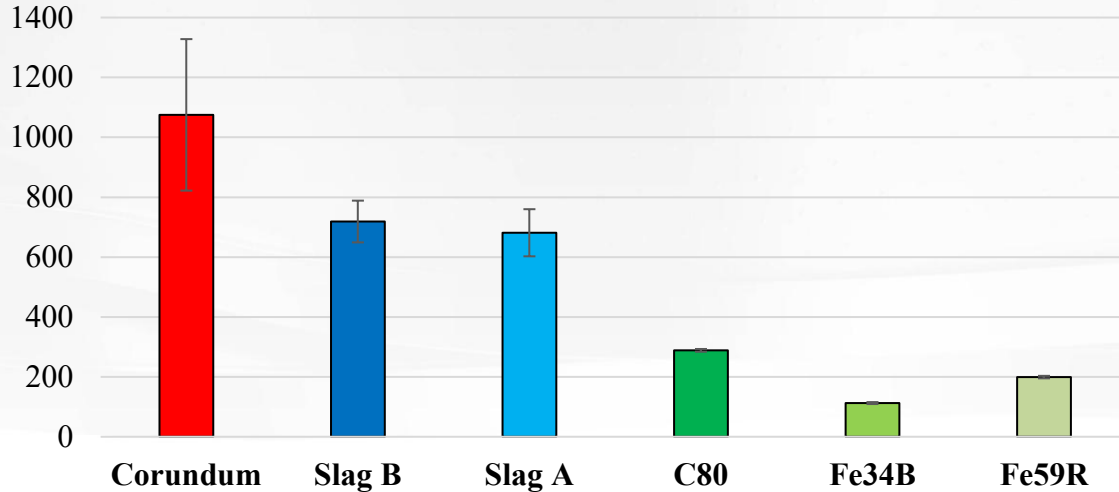


EAF Granulated Slag Characterization

The following analysis have been analyzed preliminary of granulated slag samples (Slag A and Slag B):

- Determination of Quality Hardness Index

Vickers Hardness



Slags are expected to **perform worse** than corundum but certain abrasive behaviour is expected.

Slag B is a little bit better than slag A

EAF Granulated Slag Characterization - Summary

- FeO of slag B is lower than Slag A (29 vs 38%)
- Amorphous content: presence in both slags of glassy fraction
- Compatibility from environmental point of view (leaching test)
- Spherical shape with zone with high concentration of alumina and spinel.
- Granulometry is comparable
- Hardness scale: Corundum>Slag B>Slag A> Steel Specimens

Preliminary comments:

- Spherical particles promote **rolling** over **micro-cutting**
- Glassy fraction does not contribute to abrasion properties (brittle behavior) - Amorphous phases are mechanically less stable and tend to fragment easily
- Corundum has the highest abrasive potential, although the final behavior could be controlled by morphology and friability

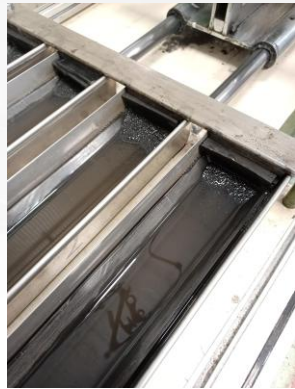
Slurry test – description and results

Slurry test carried out according to Standard **GT75-07**.

3 Materials tested: *Corundum, Slag A and Slag B*

Duration test: *2 h*

Short description: *The apparatus for test is represented by a reciprocating system provided horizontal harmonic motion at 48 r/min with a 203.2-mm travel stroke. The steel specimens were subjected to a 22.24 N (5 lb) downward force within a 50% solids concentration slurry (granulometry of solids 1.6-0.5 mm)*



Steel Samples weight is measured before and after Tests

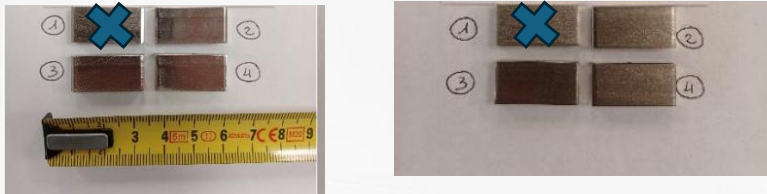
Slurry test – description and results

Slag A before and after 2 h



Average Weight Loss =
 $0,0053 \pm 0.0013$

Slag B before and after 2 h



Average Weight Loss =
 $0,0287 \pm 0,0194$

Corundum before and after 2

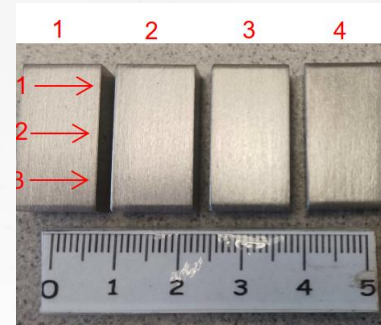


Average Weight Loss =
 $0,4009 \pm 0,1251$

The tests show that respect to standard material (Corundum), granulated slag has a lower wear behaviors

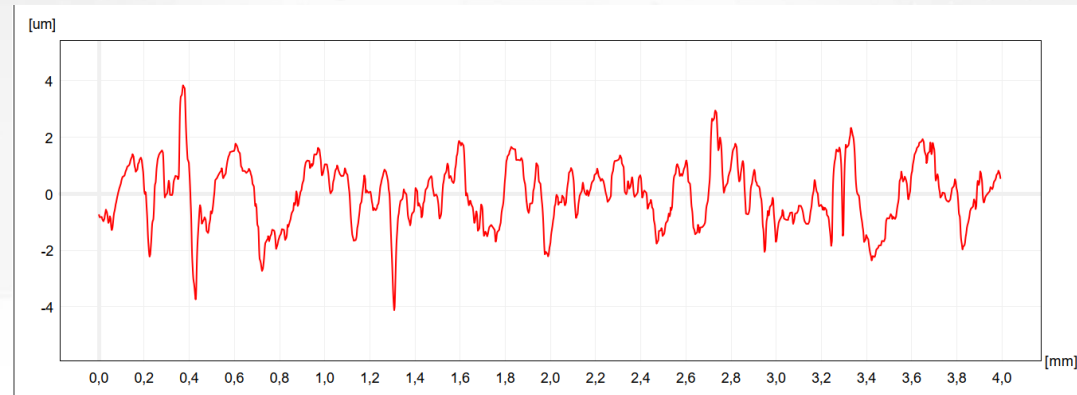
Post – test characterization – results and considerations

Roughness Measurements – for each sample, 3 measurements of roughness have been performed



Parameter **Ra** is taken as comparison value

Ra is the arithmetic mean of the absolute values of the deviations of the evaluation profile (Yi) from the mean line



Roughness Measurements

Initial Roughness
Ra = 0.8



finishing/
polishing

Ra = 0.2-
0.4

Slag B
Ra= 0.62

Slag A
Ra=0.76

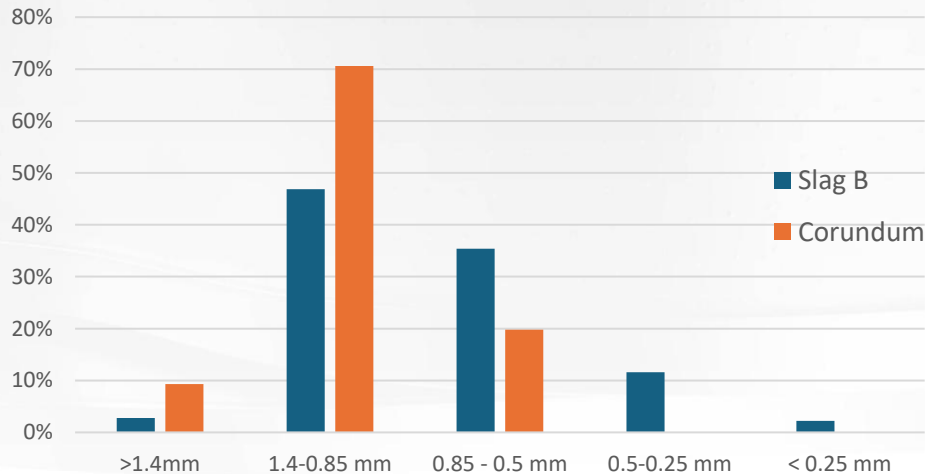
Corundum
Ra = 1.1

Lathing
technique
Ra = 1.2-
1.4



Post – test characterization – results and considerations

After test slag residual granulometry – slurry has been dried at 105°C for 8 h. Slag residual granulometry has been measured



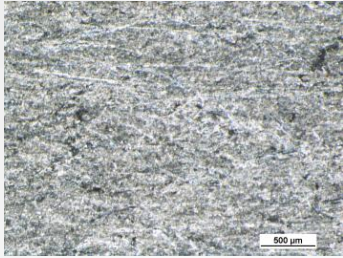
Slag B show high friability and fragmentation

50% of slag particles reduced below 0.5 mm; corundum only 20%

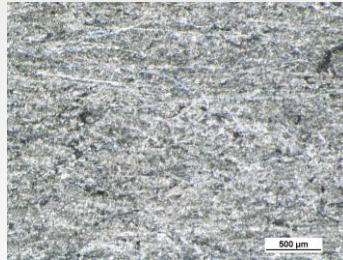
Post – test characterization – results and considerations

OM and SEM surface analysis

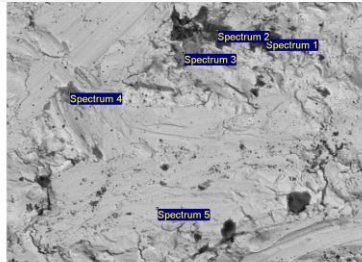
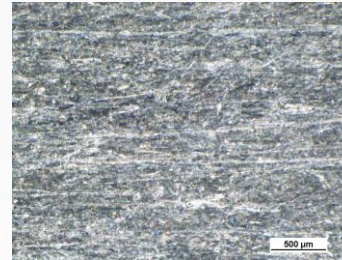
Corundum



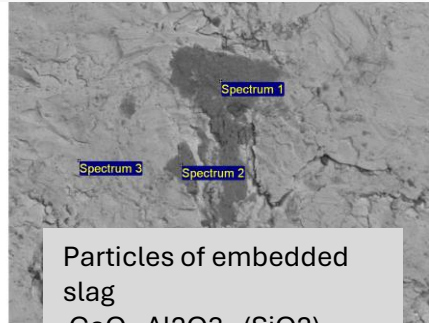
Slag A



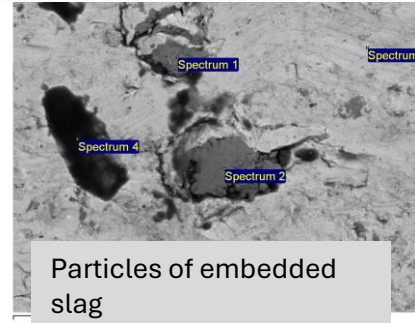
Slag B



Alumina Particles



Particles of embedded slag
 $\text{CaO} - \text{Al}_2\text{O}_3 - (\text{SiO}_2)$ slags



Particles of embedded slag
 $\text{CaO} - \text{Al}_2\text{O}_3 - (\text{SiO}_2)$ slags + Spinel Particles

- More pronounced grooves with corundum
- Particle embedding observed for all materials; residual slag rich in Al_2O_3
- Slags promote dissipative/protective mechanisms that reduce wear

Conclusions

- ❑ 2 EAF Granulated slags have been characterized and the abrasion behavior analyzed in comparison to Corundum Material
- ❑ Granulated slags A and B differ in % of FeO and they have higher content of glassy fraction respect to 100% crystalline corundum → brittle behavior respect to Corundum
- ❑ Granulated slags have spherical shape promote rolling over micro-cutting
- ❑ Slags have lower hardness than corundum but higher than steel specimens; FeO contributes to have a dense material, so abrasive applications are explored

Conclusions

- ❑ Slag A and B and corundum have been tested with slurry test in accordance to standard GT-75 07.
- ❑ Corundum abrades more due to higher hardness
- ❑ Roughness is similar for Slag A, decreases for Slag B and increase for Corundum: the spherical slags initially act through "peening" or rolling.
- ❑ The high amorphous content could explain the massive fragmentation compared to corundum (50% vs 20%).
- ❑ This fragmentation transforms the slag into a "**polishing paste,**" shifting the process from aggressive abrasion to fine slurry erosion.
- ❑ Optical analysis confirms the shift from two-body abrasion (corundum cutting) to a slurry erosion/polishing action (slags rolling and fracturing).
- ❑ **Embedding Composition:** The residues on steel samples are alumina-rich and silica-poor. The silica-rich phases (glassy) are more brittle and are washed away into the slurry upon impact. The alumina-rich phases (likely spinels or harder crystalline phases) are tough enough to remain embedded in the metal.

Conclusions – Take-away message

This study characterized two granulated slag samples (A and B) and evaluated their abrasive behavior against a Corundum reference on steel specimens.

While Corundum remains the superior material for mass removal, **granulated slags demonstrate significant potential as specialized media for surface finishing and polishing.**

Slag embedment on the surface can cause contamination and hinder subsequent treatments. Most embedded particles are rich in alumina phases. While alumina stabilizes the glassy fraction—supporting environmental compliance by reducing leaching—and enhances material density, it is also the primary contributor to surface embedment.

Future compositional optimization is therefore required to minimize contamination while preserving environmental stability.

Next steps:

- New tests on different slag composition
- Transitioning from slurry tests to air-blasting impact tests to exalt the contribution of high-density FeO phase to kinetic abrasion



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THANKS FOR ATTENTION

For more information:

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