9TH INTERNATIONAL
SLAG VALORISATION SYMPOSIUM
FROM RESIDUES TO RESOURCES AND RESILIENCE
8-11 APRIL 2025 LEUVEN, BELGIUM

CO_2 TREAT

Can dynamic mineral carbonation be used to make low carbon binders from BOF slags?

Slag Valorisation Symposium, 9 April 2020, Leuven, Belgium

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ERA-MIN 3

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Mineral carbonation technologies: products

Pre-shaped elements

Aggregates

Powders

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Use of BOF slags as low carbon binder: Challenge

BOF steel slags

- Mainly: CaO, SiO_2, Fe_xO_y
- Challenge: f-CaO 2-10%
- Volume instability
- Low reactivity as SCM (slow cooling)

Mineral carbonation as solution

- Ca_2SiO_4 + 2 CO_2 -> 2 $CaCO_3$ + SiO_2 (amorphous)
- CaO + CO_2 -> $CaCO_3$
- CO_2 uptake 150 kg/ton BOF

CEMBUREAU 2050 Roadmap
https://cembureau.eu/library/reports/cembureau-s-net-zero-roadmap/

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Accelerated CO_2 treatment of alkaline residues for low carbon binders

ERA-MIN3 project, 2022-2025

Belgium: vito, ArcelorMittal in Belgium flat products

Germany: RWTH AACHEN UNIVERSITY, Heidelberg Materials

Slovenia: ZAG

- WP 1 Low-carbon cements with CO_2-treated steel slag
- WP 2 Low-carbon concrete with CO_2-treated lignite ash
- WP 3 Geotechnical application of CO_2-treated co-combustion ash
- WP 4 Sustainability assessment
- WP 5 Exploitation, dissemination and communication
- WP 6 Project management

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BOF characterization

Main Oxides (%)	BOF slag 0-3 mm	BOF slag 3-8 mm
CaO	**43.9**	**43.0**
MgO	**3.3**	**3.4**
Al_2O_3	1.8	2.0
SiO_2	11.7	11.8
Fe_2O_3	22.1	24.7
P_2O_5	1.1	1.2
MnO	1.9	2.1
Cr_2O_3	0.2	0.2
TiO_2	0.9	0.9
BaO	0.0	0.0
V_2O_5	0.5	0.6
SO_3	0.2	0.2

		BOF 0-3 mm	BOF 3-8 mm
Minerals (%)			
Hatrurite	Ca_3SiO_5	1.7	4.1
Larnite	β-Ca_2SiO_4	**7.7**	**13.9**
Calcio-olivine	γ-Ca_2SiO_4	**4.1**	**7.7**
lime	CaO	**3.3**	**6.7**
Portlandite	$Ca(OH)_2$	**13.3**	**0.5**
calcite (CaCO3)	$CaCO_3$	1.3	0.9
aragonite (CaCO3)	$CaCO_3$	1.1	0
dolomite (CaMg(CO3)2)	$Ca(Mg(CO_3)_2)$		1.5
katoite		0.4	0
Srebrodolskite		17.4	21.9
Wustite	FeO	6.3	8.2
Fe (metal)	Fe	0.4	0.1
MgFe2O4	$MgFe_2O_4$	3.6	3.1
Pyroaurite	$Mg_6Fe_2CO_3(OH)_{16}.4H_2O$	0.4	0.3
Quartz		0.3	0.3
amorphous		38.7	30.8	
total		100	100

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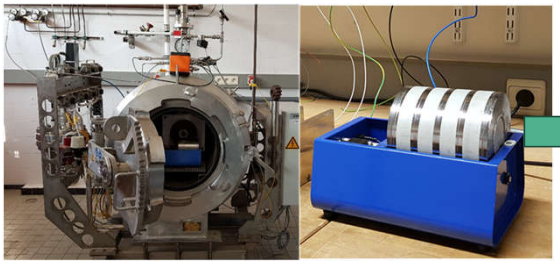
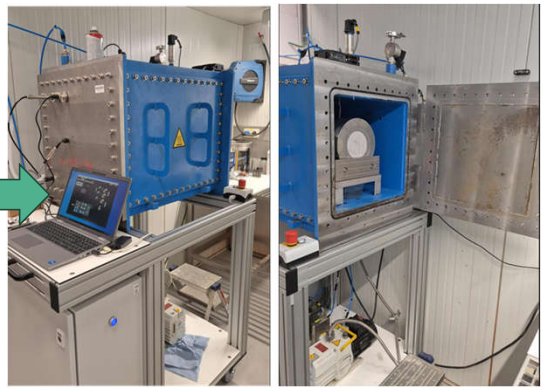
Dynamic carbonation of BOF slags towards SCMs



Parametric study – 85 g/batch



Upscaling – performance in mortar/concrete - 850 g per batch

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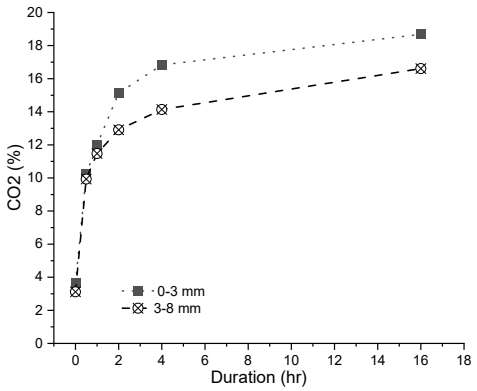
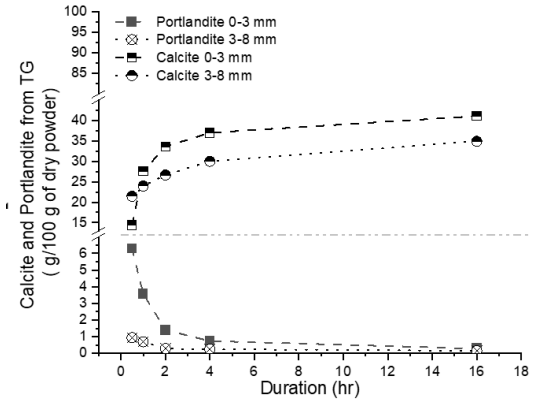
Parametric study dynamic mineral carbonation

- **Carbonation conditions: 0.5 barg CO_2, 40°C, 100% RH.**





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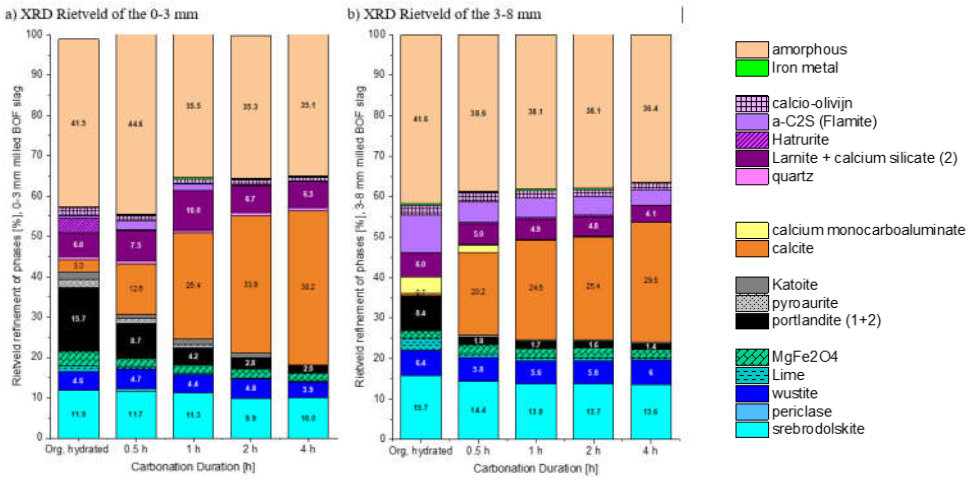
Parametric study carbonation

- **Carbonation conditions: 0.5 barg CO_2, 40°C, 100% RH.**



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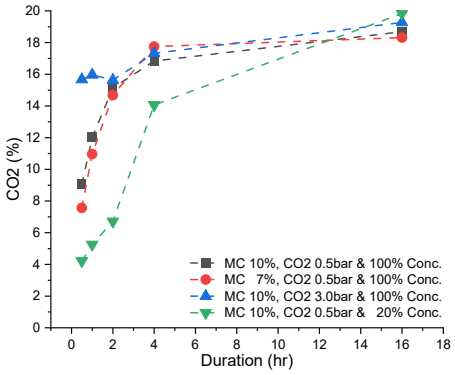
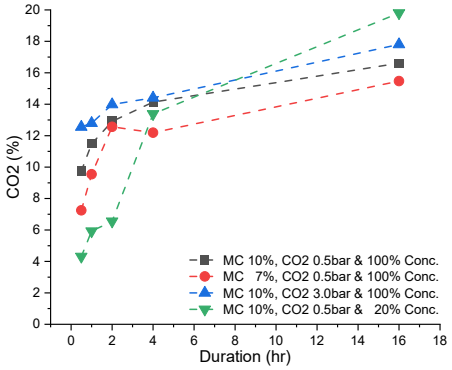
Parametric study of carbonation process

BOF 0-3 mm, T40°C, RH 100%



BOF 3-8 mm, T40°C, RH 100%



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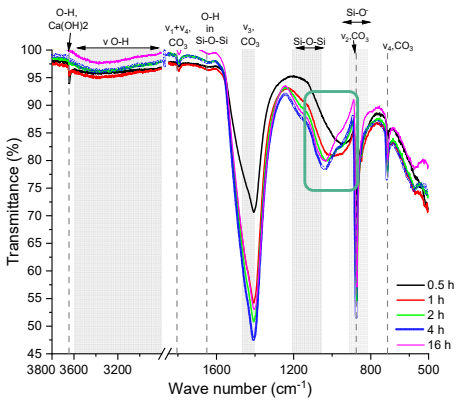
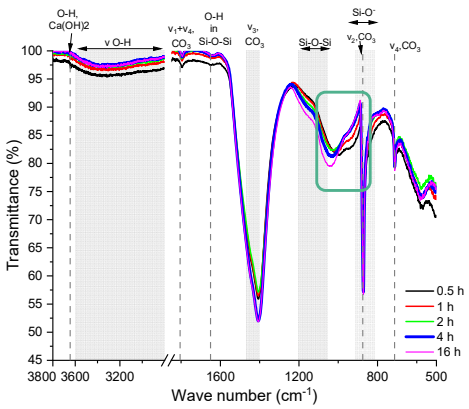
Parametric study of carbonation process - FTIR

BOF 0-3 mm



BOF 3-8 mm



$CaCO_3$ (%) from TG/DTG

	0-3 mm	3-8 mm
0.5 h	6.3%	9.4%
16 h	18.1%	15.4%

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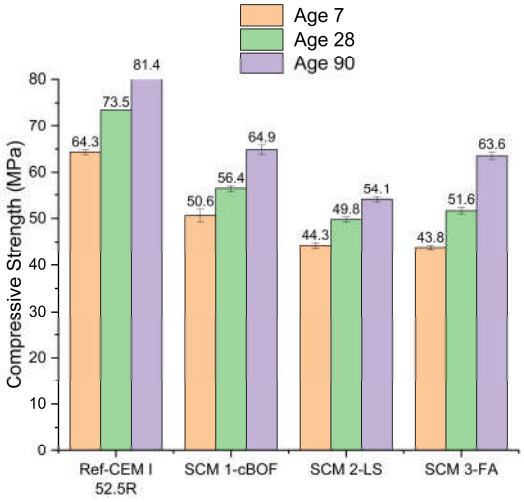
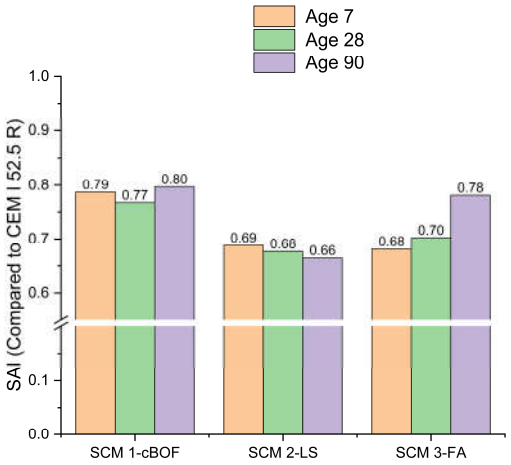
Performance of cBOF in mortar bars





At 30% replacement of CEM I 52.5 R, cBOF performs equal to commercial fly ash SCM
Next step: confirmation in concrete (S4 workability)

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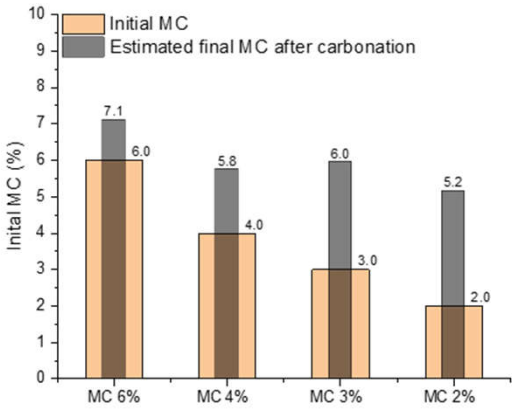
Dynamic mineral carbonation - outlook

Caking is an issue

(D99 < 90 µm,100% CO_2, 0,5 bar, 40°C, 75% RH, 4 h, TC 4,7 – 5,1%)

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$



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Novel dynamic carbonation process for BOF (vortex-based carbonation & separation)

	initial	A	B	C
d50	**41 µm**	16 µm	26 µm	76 µm
Reactive minerals	37	14	16	16
Non-reactive minerals	60	42	50	59
Ca-carbonates ($CaCO_3$)	3	44	34	25

(D99 < 90 µm, 100% CO_2, 0,1 bar, 20°C, 75% RH, 0,5 h, TC 3,2 – 6,4 %)

PATENT PENDING

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www.carbon4minerals.eu

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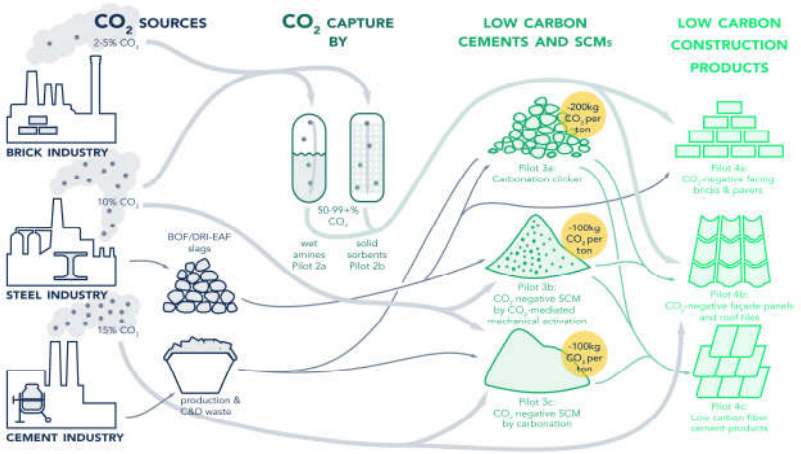

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Thank you for your attention
Questions?

https://co2treat.vito.be/en

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