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Scientific publications and technical paper list

SIMTEC

Published:

1. Sergey Semenov, Raphaël Bayle, Patrick Namy, *Numerical modelling of aluminothermic reduction for low-carbon-footprint silicon production*, Proceedings of the 34th European Modeling & Simulation Symposium (EMSS 2022), N°17, 19th International Multidisciplinary Modeling & Simulation Multiconference, Rome, Italy, September 19-21, 2022, ISSN: 2724-0029
   https://www.cal-tek.eu/proceedings/i3m/2022/emss/017/pdf.pdf

2. Sergey Semenov, Patrick Namy, Magnus Sievers, Bernd Friedrich, John Fors, Krister Engvoll, *Modelling of the ladle furnace preheating with a graphite heating rod*, Technical Papers and Presentations from the COMSOL Conference 2023, Munich, Germany, October 25-27, 2023, ISBN: 978-1-7364524-1-7
   https://www.comsol.com/paper/modeling-of-the-ladle-furnace-preheating-with-a-graphite-heating-rod-122381

3. Sergey Semenov, Patrick Namy, Magnus Sievers, Bernd Friedrich, *Modelling of an ensemble averaged electric arc in a laboratory-scale electric arc furnace*, Technical Papers and Presentations from the COMSOL Conference 2023, Munich, Germany, October 25-27, 2023, ISBN: 978-1-7364524-1-7
   https://www.comsol.com/paper/modeling-of-an-ensemble-averaged-electric-arc-in-a-laboratory-scale-electric-arc-122361

Accepted for a publication, but not published yet:

1. Sergey Semenov, Patrick Namy, Aditya Kale, Sello Tsebe, *Numerical model of aluminothermic reduction vessel preheating and charge heating with graphite heating rods*, Open Research Europe, DOI: pending
   https://open-research-europe.ec.europa.eu

2. Sergey Semenov, Patrick Namy, Aditya Kale, Sello Tsebe, *Numerical model of a top-blown rotary converter preheating and charge heating with an oxy-fuel burner*, Open Research Europe, DOI: pending
   https://open-research-europe.ec.europa.eu

3. Sergey Semenov, Patrick Namy, Aditya Kale, Sello Tsebe, *Ladle furnace preheating and charge heating with graphite heating rods*, Technical Papers and Presentations from the COMSOL Conference 2024, Florence, Italy, October 22-24, 2024, ISBN: pending

https://www.comsol.com/papers-presentations

4. Sergey Semenov, Patrick Namy, Aditya Kale, Sello Tsebe, *Top-blown rotary converter preheating and charge heating with an oxy-fuel burner*, Technical Papers and Presentations from the COMSOL Conference 2024, Florence, Italy, October 22-24, 2024, ISBN: pending
https://www.comsol.com/papers-presentations

SIMTEC conference contributions:

- **34th European Modeling & Simulation Symposium (EMSS), part of the 19th International Multidisciplinary Modeling & Simulation Multiconference (I3M), Rome, Italy, September 19-21, 2022,** oral presentation "Numerical modelling of aluminothermic reduction for low-carbon-footprint silicon production", Raphaël Bayle
- **COMSOL Conference 2023 in Munich, Germany, October 25-27, 2023,** poster presentation "Modeling of the ladle furnace preheating with a graphite heating rod", Sergey Semenov
- **COMSOL Conference 2023 in Munich, Germany, October 25-27, 2023,** oral presentation "Modeling of an ensemble averaged electric arc in a laboratory-scale electric arc furnace", Sergey Semenov
- **COMSOL Conference 2024 in Florence, Italy, October 22-24, 2024,** poster presentation "Ladle furnace preheating and charge heating with graphite heating rods", Sergey Semenov
- **COMSOL Conference 2024 in Florence, Italy, October 22-24, 2024,** oral presentation "Top-blown rotary converter preheating and charge heating with an oxy-fuel burner", Sergey Semenov

NTNU

1. **Master's thesis**: Assessing the environmental viability of silicon production by aluminothermic reduction: a comparative life cycle analysis *(Martin Våge – 2023).*
2. **Master's thesis**: Analyzing the sustainability of aluminothermic reduction of Si metal: A combined approach of MFA and spatial LCA *(Leonhard Bodau – 2023).*
3. **Master's thesis**: Mass and Energy Balanced Life Cycle Assessment of Metallurgical Grade Silicon Production *(Cathrine Nøstvold – 2022).*
4. **Master's thesis**: Life Cycle Assessment of silicon metal by aluminothermic reduction: an industrial symbiosis approach *(Elisa Pastor Vallés – 2021).*
5. **Master's thesis** : Refining Kinetics of the SisAl Silicon Alloy (*Fredrik Sørli - 2023)*
6. **Master's thesis:** Continued study to aluminothermic reduction process for silicon production (Nishan Simkhada, 2022)
7. **Master's thesis:** The Effect of Varying CaO/SiO_2 Ratios and Reductant Addition in Silicon Production by Aluminothermic Reduction of Silica Based Slags (Gjermund Lie Solbakk, 2021)

1. **PhD thesis**: Silicon Production via Aluminothermic reduction of calcium Silicate Slags (Harald G.R. Philpson, 2024) (not open)

NTNUs publications in SisAl Pilot

Published:

1. M. Zhu, A.S. Arntsen, J. Safarian, *Silicon recovery via the acid leaching of a Si-Ca-Al alloy produced by the SisAl process,* Silicon for the Chemical and Solar Industry XVI. Trondheim: Norges teknisk-naturvitenskapelige universitet 2022

2. M. Zhu, J. Safarian, *Alumina production from CaO-Al2O3-SiO2 slag produced in SisAl process,* Proceedings of the 41st International ICSOBA Conference, Dubai, 2023. (oral presentation and conference paper).

3. Kinetics of silicon production by aluminothermic reduction of silica using aluminium and aluminium dross as reductants, *Harald Philipson, Maria Wallin, Kristian Etienne Einarsrud, and Gabriella Tranell, Proceedings of the 16th International Ferro-Alloys Congress (INFACON XVI), 2021.*

4. Innovative Utilization of Aluminum-Based Secondary Materials for Production of Metallurgical Silicon and Alumina-Rich Slag, *Harald Philipson, Gjermund Lie Solbakk, Maria Wallin, Kristian Etienne Einarsrud, and Gabriella Tranell, Light Metals 2022, Cham: Springer International Publishing, 2022, pp. 1038-1045.*

5. Preliminary techno-economic considerations of the SisAl process - closing materials loops through industrial symbiosis, *Harald Philipson, Kjell Blandhol, Krister Engvoll, Veronika Djupvik, Maria Wallin, Gabriella Tranell and Torstein Haarberg, Proceedings of the Silicon for the Chemical & Solar Industry XVI, 2022.*

6. Investigation of Liquid–Liquid Reaction Phenomena of Aluminum in Calcium Silicate Slag *H. Philipson, M. Wallin, and K.E. Einarsrud. Materials, 17(7), 2024, p. 1466.*

7. Aluminothermic Reduction Kinetics of Calcium Silicate Slag for Silicon Alloy Production, *H. Philipson, M. Wallin, and K.E. Einarsrud. Metals, 14(6), 2024, p. 604.*

8. M. Zhu, J. Safarian, *Determining the properties of CaO-Al2O3-SiO2 slag system from molecular dynamics simulation,* the 12th International Conference on Molten Slags, Fluxes and Salts, Brisbane, 2024. (Oral presentation and conference paper). NOT OPEN ACCESS

9. Kai Tang, Mengyi Zhu, Jinglin You, Xiang Ma, Maria Gabriella Tranell*, Evaluation of Thermal Conductivities of Molten SiO2-Al2O3-CaO Slags,* the 12th International Conference on Molten Slags, Fluxes and Salts, Brisbane, 2024. (Oral presentation and conference paper). NOT OPEN ACCESS

10. M. Zhu, J. Safarian, *Decoding the "genome" of molten slags by molecular dynamics simulation,* the 12th International Conference on Molten Slags, Fluxes and Salts, Brisbane, 2024. (Poster presentation) NOT OPEN ACCESS??

11. K. Jakovljevic, N. Simkhada, M. Zhu, M. Wallin, and G. Tranell, *Aluminothermic production of silicon using different raw materials* the 12th International Conference on Molten Slags, Fluxes and Salts, Brisbane, 2024 NOT OPEN ACCESS

12. E Pastor-Vallés, A Vallejo-Olivares, G Tranell and J B Pettersen, *Measuring circular economy through life cycle assessment – challenges and recommendations based on a study on recycling of Al dross, bottom ash and shavings* the 12th International Conference on Molten Slags, Fluxes and Salts, Brisbane, 2024. DOI: 10.62053/IOXD6464

13. Vallejo Olivares, A.; Pastor-Vallés, E.; Tranell, G.; Pettersen, J. B. *LCA of Recycling Aluminium Incineration Bottom Ash, Dross and Shavings in a Rotary Furnace and Environmental Benefits of Salt-Slag Valorisation. Waste Management 2024.*

14. E. Emil-Kaya, F. Sørli, M. Wallin, G. Tranell, *Refining of Si-Ca-Al alloys using slag treatments.* 12th International Conference on Molten Slags, Fluxes and Salts, Brisbane, 2024

15. *M. Zhu, H. Philipson, K. Blandhol, V. Djupvik, K. Engvoll, J. Safarian, K. Tang, E. Pastor Vallés, M. Görnerup, M. Wallin, and G. Tranell.* Pilot Scale Aluminothermic Production of Silicon Alloy and Alumina-rich Slag, *ACS Sustainable Chemistry Engineering, 2024 (published).* https://pubs.acs.org/doi/epdf/10.1021/acssuschemeng.4c05326?ref=article_openPDF

Submitted – not published yet

- Comparison of Conventional and Aluminothermic Silicon Production: Life Cycle Assessment in Support of Concept Development. *Pastor-Vallés, E.; Abadías Llamas, A.; Pettersen, J. B. Environmental Science and Technology, 2024 (Submitted).*

- Life Cycle Assessment of Metallurgical Grade Silicon Comparing Charge Mixtures and Yields. Nøstvold, C.; Pastor-Vallés, E.; Andersen, V.; Tranell, G.; Pettersen, J. B. *Journal of Sustainable Metallurgy, 2024 (Accepted for publication).*

- From waste to high-purity Silicon: Refining of Silicon by directional solidification and crystal pulling method
  K. Jakovljevic, E. J. Øvrelid, N. S. Ganesan, P. Tetlie, C. Van der Eijk, M. Wallin, G. Tranell, *REWAS 2025: Sustainable Practices in Strategic and Critical Raw Materials: Exploring Supply Chain Resilience and Recycling Innovations, 2025 (Accepted for publication)*

- Regionalized LCA comparing the environmental performance of carbothermic and aluminothermic silicon production, Elisa Pastor, Gabriella Tranell, and Johan Berg Pettersen, Proceedings of the 17th International Ferro-Alloys Congress (INFACON XVII), 2024.

NTNU Conference contributions:

- **10th International Conference on Life Cycle Management (LCM2021)**: Poster presentation – Elisa Pastor Vallés.
- **11th International Conference on Industrial Ecology (ISIE2023)**: Poster presentation – Elisa Pastor Vallés.
- **Silicon conference; it's roughly 30 to 50. At the ICSOBA conference,** the audience size was about 100 people**.**
- **12th International Conference on Molten Slags, Fluxes and Salts (MOLTEN2024):** The audience size was over 340 people.
- **INFACON XVII International Ferroalloys Congress:** Over 500 attendees.

SINTEF

- Kai Tang, Casper van der Eijk, Sylvain Gouttebroze, Qiang Du, Jafar Safarian, Gabriella Tranell, Rheological properties of Al2O3–CaO–SiO2 slags,
Calphad, Volume 77, 2022, 102421, ISSN 0364-5916,
https://doi.org/10.1016/j.calphad.2022.102421.

- Machine learning - Enhanced modeling of Thermal Conductivities of Molten SiO2-Al2O3-CaO Slags Molten 2024 Conference, 12th International Conference on Molten Slags, Fluxes and Salts Supporting the Transition to Sustainable Technologies, June 2024 (Australia) (https://www.ausimm.com/conferences-and-events/molten-conferences-2024/

CITMAga publications

Title: Mathematical modeling and numerical simulation in SisAl project, an innovative pilot for silicon production
Authors: Jorge Albella[3], Alfredo Bermúdez de Castro[1,2], Óscar Crego[1], José Luis Ferrín[1,2], Branca García[1], Dolores Gómez[1,2], Luis Javier Pérez[4], Pilar Salgado[1,2] [1]CITMAga, 15782, Santiago de Compostela, Spain

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Published in: Proceedings of the XXVII Congress of Differential Equations and Applications, XVII Congress of Applied Mathematics (CEDYA/CMA)
DOI: 10.26754/uz.978-84-18321-66-5

Title: Transient mathematical modelling of a gas rotary furnace for melting slag
Authors: Óscar Crego[1], José Luis Ferrín[1,2], Dolores Gómez[1,2], Luis Javier Pérez[3], Pilar Salgado[1,2]
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MECHANICS in SCIE edition	9/137	Q1
THERMODYNAMICS in SCIE edition	**7/63**	Q1

O. Crego, J.L. Ferrín, D. Gómez, L.J. Pérez-Pérez, P. Salgado, *Transient mathematical modelling of a gas rotary furnace for melting slag,*
Applied Thermal Engineering, Volume 246, 2024, 122928, ISSN 1359-4311, https://doi.org/10.1016/j.applthermaleng.2024.122928.
(https://www.sciencedirect.com/science/article/pii/S1359431124005969)

Alfredo Bermúdez; Jorge Albella; Óscar Crego; José Luis Ferrín; Branca García; Dolores Gómez; Pilar Salgado; *Mathematical modeling and numerical simulation in SisAl project, an innovative pilot for silicon production.* Proceedings of the XVII Congress of Applied Mathematics / XXVII Congress of Differential Equations and Applications (CMA/CEDYA 2022). Zaragoza, July 18th–22nd, 2022. DOI: 10.26754/uz.978-84-18321-66-5

Title: Mathematical modelling and numerical simulation in SisAl project, an innovative pilot for silicon production
Authors: Jorge Albella[3], Alfredo Bermúdez de Castro[1,2], Óscar Crego[1], José Luis Ferrín[1,2], Branca García[1], Dolores Gómez[1,2], Luis Javier Pérez[4], Pilar Salgado[1,2]
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Published in: Book of Abstracts of XXVII Congress of Differential Equations and Applications, XVII Congress of Applied Mathematics (CEDYA/CMA)
url: https://cedya2022.es/uploads/docs/--Abstracts_CEDYA2022_(1).pdf

Conference
Title: Induction heating in SisAl project: innovative pilot for silicon production
Authors: Branca García[1], Alfredo Bermúdez de Castro[1,2], Dolores Gómez[1,2], Pilar Salgado[1,2]
[1] CITMAga, 15782, Santiago de Compostela, Spain
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Published in: Abstracts Book of XXVI Congress of Differential Equations and Applications, XVI Congress of Applied Mathematics (CEDYA/CMA)
url: https://cedya2020.es/files/8/AbstractsBookCEDYACMA.pdf

Conference
Title: Numerical Simulation of Innovative Processes for Silicon Production in SisAl Project
Authors: Dolores Gómez[1,2], Óscar Crego[1], José Luis Ferrín[1,2], Branca García[1], Pilar Salgado[1,2]
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Published in: Searchable Abstracts Document. SIAM Conference on Computational Science and Engineering (CSE23)
url: https://www.siam.org/Portals/0/Conferences/CSE23/CSE23_ABSTRACTS.pdf

Conference
Title: Numerical simulation of induction furnaces in SisAl Pilot, an innovative project for Silicon production
Authors: Óscar Crego[1], José Luis Ferrín[1,2], Branca García[1], Dolores Gómez[1,2], Pilar Salgado[1,2]
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Published in: Abstract Book 22nd ECMI Conference on Industrial and Applied Mathematics
url: https://ecmi2023.org/book-of-abstracts

Submitted – not published yet

Title: Separation Time of Aluminothermic Reduction Products for Sustainable Silicon Production
Authors: J. Bullón[1], O. Crego[2], J.L. Ferrín[2,3], D. Gómez[2,3], I. Martínez[2,3], L.J. Pérez-Pérez[4]
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4.Departamento de Ingeniería Geológica y Minera, Universidad Politécnica de Madrid, Madrid, 28003, Spain
Submitted to: Open Research Europe

Title: Multiphysics simulation of slag melting in an induction furnace for sustainable silicon production
Authors: A. Bermúdez[1,2], O. Crego[1], J.L. Ferrín[1,2], B. García[1], D. Gómez[1,2], I. Martínez[1,2], L.J. Pérez-Pérez[3], P. Salgado[1,2]
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3.Departamento de Ingeniería Geológica y Minera, Universidad Politécnica de Madrid, Madrid, 28003, Spain
Submitted to: Applied Thermal Engineering

Title: Modelling oxy-combustion dynamics in rotary kilns for sustainable silicon production: A Case Study from the SisAl Project
Authors: J.L. Ferrín[1,2], D. Gómez[1,2], I. Martínez[1,2], L.J. Pérez-Pérez[3], L. Rey[4]

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4.Fundiciones Rey, Polig. Ind. de Rubianes – Apartado 93, Vilagarcía de Arousa, 36600, Spain
Submitted to: Case Studies in Thermal Engineering

NTUA publications

Two (2) open access journal articles published:

1) Aluminium extraction from a calcium aluminate slag using sodium carbonate based on the critical examination of the patented industrial Pedersen process
(https://www.sciencedirect.com/science/article/pii/S0304386X23001706)

2) Control of Silica Gel Formation in the Acidic Leaching of Calcium Aluminate Slags with Aqueous HCl for Al Extraction (https://www.mdpi.com/2071-1050/15/21/15462)

Conferences:

1) ICSOBA 2022 - Evaluation of Alternative Raw Materials and Processes for Alumina Production (https://icsoba.org/proceedings/40th-conference-and-exhibition-icsoba-2022/?doc=29)

2) 8th International Conference of the Hellenic Metallurgical Society - Hydrometallurgical Treatment of Calcium Aluminate Slags for Alumina
Oral presentation, no published article

3) ICSOBA 2024 - ACH Calcination and Spray Roasting: Opportunities for Closing Gaps Within the Chloride Route
Presented end of October 2024, no proceedings available yet

RU Publications
SBC conference contributions
2022 Silicon Congress for chemical and solar industry, Trondheim
New metallurgical way for the solar silicon. The SisAl project

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https://doaj.org/article/e3f04d19f63e431f897e557dd9325aff
https://doi.org/10.1007/978-3-030-92529-1_135