European Training Network for the Sustainable, zero-waste valorisation of critical-metal-containing industrial process residues (SOCRATES)

D6.1 First paper by ESR1-15

This project has received funding from the European Union’s EU Framework Programme for Research and Innovation Horizon 2020 under Grant Agreement No 721385 - http://etn-socrates.eu/
Public

Authors:
[All ESRs and co-authors; Lieven Machiels, Piet Wostyn]

Date:
[20-08-2019]

Inhoud

INTRODUCTION ........................................................................................................ 4

OVERVIEW PUBLICATIONS .................................................................................... 4

ESR1 - Thupten Palden – KU Leuven - Biocompatible solvometallurgical leaching methods for low-grade industrial process residues, WP1 ................................................ 4

ESR2 - Ioanna Maria Pateli – Leicester - Ionometallurgical leaching of industrial process residues using deep-eutectic solvents, WP1 ........................................... 5

ESR3 – Samant Nagrai – Metallo - Plasma-driven metal extraction from industrial process residues, WP1 .............................................................................................. 5

ESR4 - Pelin Altinkaya – Outotec - Hydrometallurgical process for recovery the critical and valuable metal recovery from complex impure process solutions, WP1... 5

ESR5 - Stylianos Spathariotis - Leicester - Electrowinning of metals in deep-eutectic solvents, WP2 ........................................................................................................... 6

ESR6 - Ivan Korolev – Outotec - Selective electrowinning of metals from complex impure solutions, WP2 ............................................................................................... 6

ESR7 - KU Leuven – Ultrasound- and microwave-assisted non-aqueous solvent extraction in milliflow reactors, WP2 ........................................................................... 6

This project has received funding from the European Union’s EU Framework Programme for Research and Innovation Horizon 2020 under Grant Agreement No 721385 - http://etn-socrates.eu/
ESR8 - Giacomo Damilano – KU Leuven - Synthesis of extractants and ionic liquids from renewable chemicals, WP2

ESR9 - Roberto Macchieraldo – Bonn - Study of solvent miscibility by computational methods, WP2

ESR10 – Gwydyon Marchelli – UBonn - In-silico design of selective metal extractants, WP2

ESR11 – Jennifer Astoveza – Kerneos - Residual matrix valorisation as supplementary cementitious materials with calcium aluminate binders, WP3

Journal Publication

Conference Participations

ESR12 - Christina Siakati – KU Leuven - Iron-rich inorganic polymers derived from residual matrices, WP3

ESR13 – Shuang Yang – UUtrecht - Valorisation of industrial process residues as heterogeneous catalysts, WP3

ESR14 - Nikos Nikolopoulos – UUtrecht - Advanced characterisation of metal-containing, low-grade metallurgical residues, WP4

ESR15 - Alejandro Abadias Llamas – Freiberg - Development of a comprehensive product-centric sustainability indicator framework, WP4
Introduction
The European Training Network for the Sustainable, zero-waste valorisation of critical-metal-containing industrial process residues (SOCRATES) targets ground-breaking metallurgical processes, incl. plasma-, bio-, solvo-, electro- and ionometallurgy, that can be integrated into environmentally friendly, (near-)zero-waste valorisation flow sheets. The SOCRATES consortium brings together all the relevant stakeholders along the value chain, from metal extraction, to metal recovery, and to residual matrix valorisation in added-value applications, such as supplementary cementitious materials, inorganic polymers and catalysts.

The SOCRATES project kicked off in September 2016 and unites a team of young, enthusiastic PhD researchers across the E.U.. Every six months, the full consortium gathers during a Network-Wide Event (NWE) in which the Early Stage Researchers (ESRs) present their results of the past months. Feedback is provided by (co-)supervisors, partners and peers, and the perspectives towards the future are discussed. Furthermore, during these NWEs, the ESRs discuss the academic work (conference posters, presentations, and journal papers).

Below an overview is given of all publications per ESR until August 20, 2019. It should be considered that the different ESRs have a different starting date of their individual PhDs and therefore have progressed to different levels. All final publications are open access and available in online open repositories; they are also listed on the project website under ‘Communications’ – ‘Science communication’: [etn-socrates.eu/communications/science-communication/](http://etn-socrates.eu/communications/science-communication/)

Overview publications

**ESR1 - Thupten Palden – KU Leuven - Biocompatible solvometallurgical leaching methods for low-grade industrial process residues, WP1**

**Peer reviewed paper: published**

T. Palden, M. Regadio, B. Onghena, K. Binnemans, Selective Metal Recovery from Jarosite Residue by Leaching with Acid-Equilibrated Ionic Liquids and Precipitation-Stripping, *ACS Sustainable Chemistry and Engineering*, 2019, 4239-4246, DOI:10.1021/acssuschemeng.8b05938

**Peer reviewed paper: submitted**

T. Palden, M. Regadio, B. Onghena, K. Binnemans, Methanesulfonic acid: a green acidic solvent for recovering metals from jarosite residue of the zinc industry, RSC Green Chemistry.

**Conference paper**


**Conference abstract**

T. Palden, M. Regadio, B. Onghena, K. Binnemans, Selective solvometallurgical leaching of lead and zinc from jarosite using methanesulfonic acid, Presented at International Symposium on Green Chemistry (ISGC 2019), La Rochelle (France), 13-17 May 2019.
ESR2 - Ioanna Maria Pateli – Leicester - Ionometallurgical leaching of industrial process residues using deep-eutectic solvents, WP1

Papers in preparation:
2. I.M. Pateli, J. Hartley, S.S.M. Alabdullah, A.P. Abbott, Chemical and electrochemical dissolution of metal oxides in deep eutectic solvents, *tbc (xxxx).*

Conferences abstracts:

ESR3 – Samant Nagrai – Metallo - Plasma-driven metal extraction from industrial process residues, WP1

Conference paper published

Conference paper accepted

Conference paper submitted

ESR4 - Pelin Altinkaya – Outotec - Hydrometallurgical process for recovery the critical and valuable metal recovery from complex impure process solutions, WP1

Peer reviewed papers: published

This project has received funding from the European Union’s EU Framework Programme for Research and Innovation Horizon 2020 under Grant Agreement No 721385 - http://etn-socrates.eu/
Published Conference Proceedings


ESR5 - Stylianos Spathariotis - Leicester - Electrowinning of metals in deep-eutectic solvents, WP2
S. Spathariotis, N. Peeters, K. S. Ryder, A. P. Abbott, K. Binnemans and S. Riano, Separation of iron(III), zinc(II) and lead(II) from a choline chloride:ethylene glycol deep eutectic solvent by solvent extraction. In preparation

ESR6 - Ivan Korolev – Outotec - Selective electrowinning of metals from complex impure solutions, WP2
Peer-review papers published:

Conference papers published:

Other

ESR7 - KU Leuven – Ultrasound- and microwave-assisted non-aqueous solvent extraction in milliflow reactors, WP2
No publications. The contract of the recruited ESR was stopped before any publication was finalised. No new ESR has been recruited.

ESR8 - Giacomo Damilano – KU Leuven - Synthesis of extractants and ionic liquids from renewable chemicals, WP2
Peer-review papers published:

Peer-review papers submitted:
None
Peer-review papers to be submitted:

Advancements in the one-pot synthesis of symmetrical 1,3-dialkylimidazolium salts: solvents, surfactants, extractants, and physical gelators – Under writing

Analysis on the effects of thiol substitution in low transition temperature mixtures (LTTMs) – Under writing

Comparison of 1-butyl-3-methyl-imidazolium tetrafluoroborate ionic liquids with different configurational isomers of the cation – Under writing

ESR9 - Roberto Macchieraldo – Bonn - Study of solvent miscibility by computational methods, WP2

Peer-review papers published:

1. Macchieraldo, [...], Kirchner. “Hydrophilic ionic liquid mixtures of weakly and strongly coordinating anions with and without water”

2. Gehrke, [...], Kirchner. “Understanding the fluidity of condensed phase systems in terms of voids---Novel algorithm, implementation and application”

3. Macchieraldo, [...], Binnemans, Kirchner. “Tuning Solvent Miscibility: A Fundamental Assessment at the Example of Induced Methanol/n-Dodecane Phase Separation”


ESR10 – Gwydyon Marchelli – UBonn – In-silico design of selective metal extractants, WP2

Peer-review papers published:


Poster in preparation


ESR11 – Jennifer Astoveza – Kerneos - Residual matrix valorisation as supplementary cementitious materials with calcium aluminate binders, WP3

Journal Publication

J. Astoveza; R. Trauchessec; R. Soth; Y. Pontikes, Fe-rich Slag Reactivity in Calcium Aluminate Blended Cement – first draft expected at the end of November 2019
**Conference Participations**


4. J. Astoveza; R. Trauchessec; R. Soth, *Quantifying the Degree of Fe-rich Slag Hydration in Calcium Aluminate Blended Cement by Image Analysis of SEM-BSE and XCT data*, International Process Metallurgy Symposium (IPMS 2019), Espoo, Finland, 5-6 November 2019 – oral presentation


---

**ESR12 - Christina Siakati – KU Leuven - Iron-rich inorganic polymers derived from residual matrices, WP3**

- **Published:**

- **Submitted:**
• Under preparation

1. Siakati C, Macchieraldo R, Kirchner B, Tielens F, Peys A, Seveno D, Pontikes Y. Elucidating the impact of chemical variability on the nano-structure and reactivity of Fe-rich slags. (To be submitted)

2. Siakati C, Douvalis AP, Peys A, Pontikes Y. Fe ions distribution after alkali-activation of Fe-rich slags. (To be submitted)

ESR13 – Shuang Yang – UUtrecht - Valorisation of industrial process residues as heterogeneous catalysts, WP3

No publications yet. The contract of the recruited ESR was stopped before any publication was finalised. A new ESR has been recruited beginning of August 2019.

ESR14 - Nikos Nikolopoulos – UUtrecht - Advanced characterisation of metal-containing, low-grade metallurgical residues, WP4

Peer-review papers to be submitted:


N. Nikolopoulos, R.G. Geitenbeek, B.M. Weckhuysen Revealing the influence of impurities on the stability of waste-derived zeolite ZSM-5 under hydrothermal treatment Green Chemistry

N. Nikolopoulos, A. Malfliet, R.G. Geitenbeek, P. Muchez, B.M. Weckhuysen Trace In, Sb and Ag in low concentrations incorporated in waste mine tailings Chemical Geology

Peer-review papers published:

Not yet

Peer-review papers submitted:

Not yet

Conference papers published:


ESR15 - Alejandro Abadías Llamas – Freiberg - Development of a comprehensive product-centric sustainability indicator framework, WP4

Peer-review papers published:


Peer-review papers submitted:


Peer-review papers to be submitted:

Conference papers published:


