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## PRIKAZI REVIEWS

### 7<sup>th</sup> EUROPEAN METALLURGICAL CONFERENCE EMC2013

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#### *Abstract:*

*From June 23 – 26, 2013, the GDMB Society for Mining, Metallurgy, Resource and Environmental Technology organized 7th European Metallurgical Conference (EMC 2013) in Weimar, Germany. The previous European metallurgical conferences were organized by the GDMB in Friedrichshafen (2001), Hanover (2003), Leipzig (2005), Duesseldorf (2007), Innsbruck (2009), and Duesseldorf (2011). The GDMB is a non-profit organization from Clausthal, Germany, focused on combining science with practical experience in metallurgy, mining, materials engineering, mineral processing, recycling and refining of metals, and manufacturing of semi- and finishing products. The European Metallurgical conference EMC is one of the most well-known conferences worldwide in the field of non-ferrous metallurgy and is attended regularly by decision makers from industry and universities. The scientific program contained 6 plenary lectures and more than 130 presentations. An extensive poster exhibition was held, during which the authors had an opportunity to introduce their posters to the entire plenum as a part of a brief presentation. The € 500 worth "Poster Award EMC 2011 was awarded to Christoph Pichler from the Montan-University in Leoben, Austria. Not only the most important European countries were represented here, but also more than one third of the lecturers were from countries outside Europe (Canada, Japan, China, USA, South Africa, Australia). The origin of the participants reflects the aim of the organizers: to make this conference a worldwide platform for*

*the scientific exchange of experience and information. The scientific presentations of the conference are presented in Proceedings:*

*Vol. 1: Copper, Precious Metals, Waste effluents Treatment/ Bio-hydrometallurgical applications; Process Metallurgy, Bridging Non-Ferrous and Ferrous Metallurgy;*

*Vol. 2: Lead and Zinc, Light metals, Sustainable technologies, Sustainable of non-ferrous metals production, Process Control/Process Modelling, Waste heat recovery by ORC Power Generation*

*Vol. 3: General Hydrometallurgy, General Pyrometallurgy, Vessel Integrity, Process Gas Treatment; Recycling*

*The plenary lectures will be published in the scientific journal "World of Metallurgy – ERZMETALL", published by GDMB. The next 8<sup>th</sup> European Metallurgical Conference will be held between June 14 and June 17, 2015 in Duesseldorf.*

*Ključne reči: nonferrous metallurgy; recycling; hydrometallurgy; metal; environmental protection.*

## Introduction

In his welcoming speech for 7<sup>th</sup> EMC 2013 in Weimar, Professor Dr.-Eng. Hans Jacobi, President of the GDMB, pointed out that the EMC2013 has spread out beyond European borders (Eicke, 2013, pp.32-35). The colleagues from RWTH Aachen University, Germany; Rubamin Ltd, India; University of British Columbia, Canada; Tohoku University, Japan; Facultad de Ingenieria UNAM, Mexico; and Montan University of Leoben, Austria, participated in the work of the Scientific Advisory Board. The Co-sponsoring Societies are most important metallurgical associations: The Austrian Society for Metallurgy and Materials, Austria- ASMET; EUnited Metallurgy- the European Metallurgical Equipment Association, Belgium; The Norwegian Society for Materials Technology, Norway; Instituto de Ingenieros de Minas de Chile; Metallurgical Society of CIM, Canada; The Mining and Materials Processing Institute of Japan; REWIMET-Recycling-Cluster wirtschaftlicher Metalle Niedersachsen e.V., Germany; SITMN Stowarzyszenie Inżynierów i Techników Metali Nieżelaznych, Poland; SF2M Societe Francaise de Metallurgie et de Materiaux, France; Verband der Aluminium Recycling- Industrie e.V. Verband Deutscher Maschinen und Anlagenbau e.V und Verband Deutscher Metallhändler; The South African Institute of Mining and Metallurgy (SAIMM), South Africa. Between the 20 chosen chairmen, one colleague was from Serbia: Dr. Nikola Anastasijevic, Outotec GmbH. The EMC 2013 represents a signal to the world that metallurgical industry is innovative and active and faces with technical, ecological and economic challenges. The presentations were a good basis to find new processes and new solutions in metallurgy.

## Plenary lectures

Plenary lectures of general interest for all conference participants were reported on Monday, June 24, 2013 and Wednesday, June 26, 2013. The list of plenary lectures:

1. **Bell, Oliver:** Non-Ferrous Metals- Today and Tomorrow; Political and Economical Prospects; Norsk Hydro ASA, WirtschaftsVereinigung Metalle e.V., Germany
2. **Dreisinger, David:** New development in the hydrometallurgical processing of sulfidic copper ores and concentrates, University of British Columbia, Department of Materials Engineering, Canada
3. **Ignat, Miguel:** The Quality control and traceability: A Permanent challenge for technological applications. An example from copper industry in Chile; University of Chile
4. **Jones, Rodney:** Electric Smelting in Southern Africa, Mintek, South Africa
5. **Owada, Shuji,** Japan's technological approach To recover minor rare Metals from E-wastes, Waseda University, Faculty of Science and Engineering, Japan
6. **Willbrandt, Peter,** Raw Material Supply and resource Efficiency in the European Copper industry, Aurubis AG, Germany

## The chosen lectures

### *Implementation of a Novel Technology for the Recovery of Cobalt from Copper Smelter*

Slags Hira Singh, Chambishi Metals Plc, Zambia, South Africa

**Bernd Friedrich,** IME Process Metallurgy and Metal Recycling, RWTH Aachen University, Germany

This study shows improvements and modifications carried out on the feed system to create charge bank, selection of flux to modify slag chemistry, modification of alloy chemistry, re-configuration of the power control system and increased atomization capacity in Chambishi Metals Plc. in South Africa, which started in 2001 with a selective carbothermic reduction for processing the furnace slag stockpile of 20 million tons containing 0.34 to 4.5 % cobalt, and an average of 1.1 % copper. Cobalt occurs as faylite whereas copper occurs as oxide and sulphide. An atomizer unit to atomize a furnace product, molten Co/Cu/Fe alloy, and a pressure oxidation leach process to leach cobalt and copper and separate iron as goethite was also commissioned. The cobalt and copper containing solution is processed in the refinery for the production of metals. The commissioning and ramp up period was much longer than projected due to a premature failure of the hearth and other operational problems

associated with the feed system, cooling system and power control. The furnace availability was low and affected the throughput and metal production. This put tremendous pressure on the company due to poor cash flow and non-repayment of the capital resulting in a sale of 100 % of its share in July 2003. A subsequent systematic analysis to debottleneck the furnace operation was successful, resulting in the attainment of design throughputs. The Plant Historian Database (PHD) was used for the analysis. The commercial application of the DC arc furnace for smelting copper smelter slag was unique and therefore required extensive literature search to broaden the knowledge of the theory and the practice. The paper shows the improvements and modifications of the feed system in order to create charge bank, selection of flux to modify slag chemistry, modification of alloy chemistry, re-configuration of the power control system and increased atomization capacity. These implementations resulted in the furnace performance reaching the designed levels.

### *Synthesis of Copper Chromium Alloys by Aluminothermal Reduction*

**S. Hassan Pour**, B. Friedrich

RWTH Aachen, IME Process Metallurgy and Metal Recycling

In order to define the process window parameters like intrinsic chemical energy (enthalpy of the reaction mixture), equilibrium temperature and physical properties (particle size and mixing degree) were optimized in the synthesis of copper-chromium alloys by a cost-reduced aluminothermal reduction process under the investigation of IME, RWTH Aachen University. Due to a combination of high thermal and electrical conductivity, high strength and long term stability, Copper-Chromium materials are widely used in high voltage applications as electrical high-power contacts and vacuum interrupters. The binary system of Copper and Chromium shows nearly complete immiscibility in the solid state. In order to obtain Copper-Chromium materials with a mass fraction of Chromium between 10 % and 55 wt.-%, extensive and cost-intensive production processes are required to obtain a uniform distribution of Chromium particles in the Copper matrix. Cu-Cr contact materials are currently produced by powder metallurgical or VAR technologies. Regarding this new method, this paper presents the first approach to produce Copper-Chromium material with Chromium mass contents higher than 25 % by a joint aluminothermic reduction of Chrom- and Copper-oxides in a laboratory scale. The aluminothermic reduction shows high-potential for an alternative production method for Copper-Chromium materials due to its high heating rates, high temperatures and short reactions times combined with its self-propagating behavior.

### *Recovery of yttrium from waste crucible materials*

**S. Stopić,** B. Friedrich, RWTH Aachen, IME Process Metallurgy and Metal Recycling, Aachen

M.Lerch, R.Gerke-Cantow, Tital GmbH, Bestwig

Yttrium compounds find interesting applications in many industrial fields (superconductors, catalysis, crucible, oxygen sensor). The feasibility of using yttrium oxide as a crucible material or coating respectively for induction melting of titanium is widely used in metallurgy. During the production of crucibles based on yttrium oxide as well as through the melting/casting operations, significant waste materials were formed. In this study, the recovery of yttrium from various waste crucible materials by chlorination, leaching and a subsequent precipitation was investigated. The solubility of available yttrium oxide in waste materials is a function of concentration, type of the used chlorinating/ leaching reagent as well as other process parameters. Chlorination and the carbochlorination process were investigated in order to obtain yttrium chloride from waste crucible materials using ammonium chloride ( $\text{NH}_4\text{Cl}$ ), and calcium chloride ( $\text{CaCl}_2$ ) as chlorinating agents and added sucrose. The tests were conducted in a muffle furnace at 400 °C and 600 °C and at different times - 15, 30 and 60 min. Selective dissolution of yttrium was investigated in solutions with  $(\text{NH}_4)_2\text{CO}_3$ , HCl,  $\text{H}_2\text{SO}_4$  and  $\text{HNO}_3$  under atmospheric and high pressure conditions aiming at the process efficiency and the feasibility for industrial application.



Figure 1 – Presentation of Dr. Stopić at EMC 2013 in Weimar  
Slika 1 – Prezentacija dr Stopića na EMC 2013 u Weimaru

## *Efficiency of Slag Cleaning in a Magnetically Induced Stirring Reactor*

**M. Zander**, B. Friedrich – IME Process Metallurgy and Metal Recycling, RWTH Aachen University;  
 M.Hoppe, J.Schmidl – Aurubis AG;  
 R.Degel, J.Kleinschmidt – SMS Siemag AG

Slags generated in pyrometallurgical copper processes are mineral by-products governed by the regulations applicable in building and construction industries. To extend the range of applications and safeguard its EU product classification, sustainable purification and homogenisation of slag is required. The experiments in two reactors were carried out as a part of a collaborative project funded by the Federal Ministry of Education and Research (BMBF). The fundamentals and theoretical background to this were published at EMC 2011 in Duesseldorf in Germany. A pilot-scale stirring reactor, integrated in the industrial process, was operated in a number of weekly campaigns and treated two tons per hour of slag at AURUBIS (former Norddeutsch Affinerie), Hamburg in a semi-continuous operation. The reproducible results prove the effect of the magnetic and electric field on the settling behavior of metal/matte droplets in fayalitic slags. A second, smaller demo-scale stirring reactor was designed and installed at IME, RWTH Aachen University. It facilitates shorter campaigns with synthetic slags of steady qualities and short response times. The aim is to examine the physical and metallurgical principles behind this process in more detail. This test unit allows throughputs of about 0.5 ton of molten slag per hour in a 1 MW electric smelter or a 0.5 MW TBRC. Plans to transfer this technology to other slag systems, for example from Pb, PGM or Ni production, are envisaged for future research programs.

## *First Results of Scale Up of Ultrasonic Spray Pyrolysis Process for Nanopowder production*

**J. Bogovic**, S.Stopić, B. Friedrich, IME Process Metallurgy and Metal Recycling, RWTH Aachen University;  
 G.Matula, Elino Industrie Ofenbau GmbH, Duren, Germany  
 R.Rudolf- Faculty of Mechanical Engineering, Maribor, University

This paper presents a report of the first results on the scale up of Ultrasonic Spray Pyrolysis (USP) process performed at the RWTH Aachen University. In previous publications it was confirmed that the Ultrasonic Spray Pyrolysis is a relatively inexpensive and quite versatile technique for

the preparation of nanosized metallic, oxidic and composite particles production based on an aerosol process (Bogovic, et al, 2011, pp.1053-1064), (Matula, et al, 2013, pp.46-50), (Rudolf, et al, 2012, pp.595-612), (Stopić, et al, 2006, pp.377-382), (Stopić, 2013, pp.99-112). The formation of precisely controlled morphology and defined chemical compositions from water solution was investigated using different metal salts and their mixtures. In the first trial on the big scale USP equipment, nanosized silver powder was produced at this equipment (Stopić, 2013, pp.99-112).



*Fig. 2 – Scale up of the USP-process (J.Bogovic, S.Stopic, A.Schwinger)  
(Matula, et al, 2013, pp.46-50)*

*Slika 2 – Uvecana proizvodnja za USP-proces (J.Bogovic, S.Stopic, A.Schwinger)  
(Matula, et al, 2013, pp.46-50)*

## Conclusion

The scientific presentations of 7<sup>th</sup> European Metallurgical Conference in Weimar between 23 and 26 June 2013 were presented by 130 lecturers. More than 20 companies were present at the Exhibition in Weimarhalle in Weimar. There were more than 350 interested visitors from all continents. Christoph Pichler, BSc Eng, from Montanuniversität, Austria, was awarded with 500 € for the best poster: "Slag and Residues Treatment: Process Development and Refractory Evaluation. The 7<sup>th</sup> European Metallurgical Conference with more than 350 visitors from all continents has again confirmed that metallurgical industry is highly innovative and faces with ecological and economic challenges with big success.



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## SEDMA EVROPSKA KONFERENCIJA O METALURGIJI – EMC2013

OBLAST: materijali

VRSTA ČLANKA: prikaz

### Sažetak:

Udruženje za rudarstvo, metalurgiju, sirovine i tehnologije za zaštitu životne sredine (GDMB) organizovalo je od 23. do 26. juna 2013. u Weimar-u u Nemačkoj Sedmu evropsku konferenciju o metalurgiji – EMC 2013. Prethodne evropske konferencije o metalurgiji održane su u Fridrihshafen-u (2001), Hanoveru (2003), Lajpcigu (2005), Diseldorfu (2007), Insbruku (2009) i Diseldorfu (2011). GDMB je neprofitna organizacija sa sedištem u Klausthalu u Nemačkoj, koja se bavi povezivanjem nauke i praktičnih iskustava u metalurgiji, inženjerstvu materijala, procesiranju minerala, recikliranju, rafinaciji metala, proizvodnji poluproizvoda i završnih proizvoda. Evropska konferencija o metalurgiji EMC jedna je od najpoznatijih konferencija širom sveta u oblasti obojene metalurgije i redovno je posećena od eminentnih stručnjaka sa univerziteta i iz industrije. Naučni program sadržao je šest plenarnih predavanja i više od 130 prezentacija iz trideset zemalja u pet paralelnih sekcija. Održana je dodatna poster-sekcija, gde su autori imali mogućnost da predstave svoje rezultate i održe po kratku prezentaciju. Najbolji poster sa Montan univerziteta u Leobenu u Austriji predstavio je

*Christoph Pichler koji je nagrađen sa pet stotina evra. Sem autora iz Evrope, više od jedne trećine predavača bilo je iz zemalja izvan Evrope (Kanada, Japan, Kina, Amerika, Južna Afrika, Australija). Poreklo učesnika potvrđuje cilj organizatora da stvori jednu konferenciju sa širokom platformom za razmenu naučnih ideja i informacija i razvijanje poslovnih kontakata. Naučne prezentacije predstavljene su u tri sesije.*

*Prva sesija: Bakar, Plemeniti metali, Preradna otpadnih materijala, Primene biohidrometalurških procesa, Procesna metalurgija, Povezivanje obojene metalurgije i metalurgije gvožđa i čelika. Druga sesija: Olovo i cink, Laki metali, Održive tehnologije i održivost proizvodnje obojenih metala, Procesna kontrola, Procesno modelovanje, Ponovno korišćenje otpadne toplote iz elektrana. Treća sesija: Opšta hidrometalurgija, Opšta pirometalurgija, Reaktori, Tretman procesnih gasova, Recikliranje.*

*Plenarna predavanja biće objavljena u naučnom časopisu: ERZMETALL Svet metalurgije – Rude i metali, koji izdaje udruženje za metalurgiju i rudarstvo GDMB. Osmu Evropska konferencija metalurgije planirana je od 14. do 17. juna 2015. u Diseldorfu.*

*Ključne reči: obojena metalurgija, recikliranje metala, hidrometalurgija, metali, zaštita životne sredine.*

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