

CROATIAN METALLURGICAL SOCIETY (CMS)  
HRVATSKO METALURŠKO DRUŠTVO (HMD)

16<sup>th</sup> INTERNATIONAL / 16. MEĐUNARODNI

SYMPOSIUM OF CROATIAN METALLURGICAL SOCIETY  
SIMPOZIJ HRVATSKOG METALURŠKOG DRUŠTVA

# S H M D '2023

MATERIALS AND METALLURGY / MATERIJALI I METALURGIJA  
BOOK OF ABSTRACTS / ZBORNİK SAŽETAKA

*Obljetnice Hrvatskog metalurškog društva*  
*Anniversaries of Croatian Metallurgical society*

1952.-2022. HRVATSKO METALURŠKO DRUŠTVO / CROATIAN METALLURGICAL SOCIETY / 70 god./y

1962.-2022. ČASOPIS METALURGIJA / METALURGIJA JOURNAL / 60 god./y



ZAGREB, CROATIA, April 20 – 21, 2023  
ZAGREB, HRVATSKA, 20. – 21. travanj 2023.

## THE AIM OF SYMPOSIUM

The aim of this Symposium is to point out all the possibilities of the materials and achievements in metallurgy.

## TOPICS OF THE SYMPOSIUM WERE:

### Materials

- New Materials
- Refractory Materials
- The Development
- Applications
- Physical Metallurgy

### Metallurgy

- Process Metallurgy and Foundry
- Plastic Processing of Metals and Alloys
- Technologies
- Energetics
- Ecology in Metallurgy
- Quality Assurance and Quality Management

16<sup>th</sup> International Symposium of Croatian Metallurgical Society „Materials and Metallurgy“ was held as a part of Anniversaries:

**1952.–2022. HRVATSKO METALURŠKO DRUŠTVO / CROATIAN METALLURGICAL SOCIETY**

**1962.–2022. ČASOPIS METALURGIJA / METALURGIJA JOURNAL**

„Countries Participating at the 16<sup>th</sup> International Symposium of Croatian Metallurgical Society“ – total 50 „Organizer“, „Co-organizer“, „Co-operation with organizations“, same as 15<sup>th</sup> symposium, Please see Metalurgija 62 (2023) 1, 8-10

## ACCEPTED ABSTRACTS

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## PATRONS (same as for 15 th Symposium)

- World Steel Association (WSA)
- International Society of Steel Institutes (ISSI)
- European Steel Federation (ESF)
- European Steel Institute Confederation (ESIC)
- University of Slavonski Brod, Faculty of Mechanical Engineering, Croatia
- University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture, Croatia

## NAPOMENA:

- Mnogi autori / koautori nisu se pridržavali zadanog oblika i dužine sažetaka referata. Znanstveni odbor je izveo usaglašavanje, te isprika ako postoje nedostaci. Moguće je i možebitni izostanak nekog sažetka. Sve Reklamacije se usvajaju do 30. travnja 2023. god., posebice tisak, Metalurgija 62 (2023) 3.

## NOTE:

- Many authors / co-authors have not observed the given form and length of abstracts of their reports. Scientific board has made adjustments, so we apologize if there are any faults. An abstract might be failing. All Protests will be accept till April 30, 2023, and after separately publish, Metalurgija 62 (2023) 3.

## SCIENTIFIC COMMITTEE

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*Dear Participants, Authors, Co-authors et al.,*

*Thirty years (1993-2023) have passed since foundation of International Symposiums of Croatian Metallurgical Society „Materials and Metallurgy“. First Symposium (September 15-17, 1993) was postponed due to war operations in Sisak, and subsequently held in Zagreb, February, 16-18, 1994. Till now total 16, Countries participating were about 50, over 70 different Institutions, total 6 459 Abstracts of over 10 000 Authors and Co-authors.*

*Dear al., my thanks to You, because without You this Symposiums would have never come about.*

*Special thanks and compliments are to many Members of Committees Scientifics, Organizing, Honour Boards, Reviewers, Chairman of Sections etc.*

*I just hapen to be first amoving equals.*

*Leader of all Symposiums*

*Akad. I. Mamuzić, Prof.h.c.,dr.h.c.*

### Countries Participating at the 16<sup>th</sup> International Symposium of Croatian Metallurgical Society “Materials and Metallurgy”

<b>1</b> Argentina	<b>18</b> Greece	<b>35</b> Portugal
<b>2</b> Austria	<b>19</b> Hungary	<b>36</b> Romania
<b>3</b> Belgium	<b>20</b> India	<b>37</b> Russia
<b>4</b> Belarus	<b>21</b> Indonesia	<b>38</b> Saudi Arabia
<b>5</b> Benelux	<b>22</b> Iran	<b>39</b> Serbia
<b>6</b> Bosnia and Herzegovina	<b>23</b> Italy	<b>40</b> Singapore
<b>7</b> Brazil	<b>24</b> Japan	<b>41</b> Slovakia
<b>8</b> Bulgaria	<b>25</b> Kazahstan	<b>42</b> Slovenia
<b>9</b> Chile	<b>26</b> Korea	<b>43</b> South Africa
<b>10</b> China	<b>27</b> Lithuania	<b>44</b> Spain
<b>11</b> Croatia	<b>28</b> Macedonia	<b>45</b> Sweden
<b>12</b> Czech Republic	<b>29</b> Malaysia	<b>46</b> Thailand
<b>13</b> England	<b>30</b> Mexico	<b>47</b> Turkey
<b>14</b> Egypt	<b>31</b> Montenegro	<b>48</b> Ukraine
<b>15</b> Finland	<b>32</b> Netherlands	<b>49</b> USA
<b>16</b> France	<b>33</b> Philippine	<b>50</b> Vietnam
<b>17</b> Germany	<b>34</b> Poland	

### All 16 Symposiums have been held:

- 1<sup>st</sup> Zagreb: 1994, February, 16-18 (88 lectures)
- 2<sup>nd</sup> Split: 1996, June, 20-22 (150 lectures)
- 3<sup>rd</sup> Šibenik: 1998, June, 25-27 (192 lectures)
- 4<sup>th</sup> Opatija: 2000, June, 25-29 (333 lectures)
- 5<sup>th</sup> Šibenik: 2002, June, 23-27 (375 lectures)
- 6<sup>th</sup> Šibenik: 2004, June, 20-24 (368 lectures)
- 7<sup>th</sup> Šibenik: 2006, June, 18-22 (475 lectures)
- 8<sup>th</sup> Šibenik: 2008, June, 22-26 (615 lectures)
- 9<sup>th</sup> Šibenik: 2010, June, 20-24 (541 lectures)
- 10<sup>th</sup> Šibenik: 2012, June, 17-21 (641 lectures)
- 11<sup>th</sup> Šibenik: 2014, June, 22-26 (689 lectures)
- 12<sup>th</sup> Šibenik: 2016, June, 19-23 (546 lectures)
- 13<sup>th</sup> Šibenik: 2018, June, 24-29 (561 lectures)
- 14<sup>th</sup> Šibenik: 2020, June, 21-26 (435 lectures)
- 15<sup>th</sup> Zagreb: 2022, March, 22-23 (527 lectures)
- 16<sup>th</sup> Zagreb: 2023, April, 21-22 (259 lectures)

**45. Yefimenko, I. Mamuzić**

**Development of the technology of using fuel of plant origin in the burning of iron ore pellets.** Iron ore requires agglomeration, which consumes a lot of fuel, which is accompanied by harmful emissions. An alternative is to use biomass to partially replace fossil fuels. A technology has been developed for replacing fossil fuels with biofuels during the firing of pellets. When burning sunflower husks, heat is released to replace up to 48,3 % of natural gas. Using biogas instead of natural gas also has its advantages. The possibility of producing carbon-containing pellets from agricultural waste and palm shells is considered. The use of biomass as a reducing agent in iron ore mining has proven to be a suitable method for improving the quality of iron ore as well as reducing CO<sub>2</sub> emissions.

**46. T. Wojtal**

**The influence of temperature on the speed of reduction of tin oxide with argon-hydrogen mixture.** Recently, the usage of hydrogen in the processes of metal extraction has been a very important challenge to metallurgical industry. Replacing conventional reductor, taking into consideration CO<sub>2</sub> emission restrictions will enable maintaining and developing this branch of industry. The results of the research on tin oxide SnO reduction using hydrogen given as a mixture Ar – 5 % vol. H<sub>2</sub> in temperature range 773 – 873 K. are shown in this article. The tests were conducted using thermogravimetric method. It is demonstrated that with the rise of a temperature in the analyzed range the speed of reaction rises as well and the obtained degree of reduction varies from 40 to 99,5 %. Stabilization the weight change in the tested sample thermogravimetric (TG) was reached after from 25 min for 773 K to 15 min for temperature 873 K.

**47. Ye. Kuatbay, A. Nurumgaliyev, T. Zhuniskaliyev, S. Smailov, A. Yerzhanov, G. Bulekova**

**Development of carbon ferrochrome smelting technology using high-ASH coal.** This article presents the results of experimental tests using coal from the Saryadyr deposit as a reducing agent for the smelting of carbonaceous ferrochrome. Large-scale laboratory tests were carried out on the smelting of carbonaceous ferrochrome in an ore-thermal furnace with a capacity of 200 kV · A. X-ray diffraction analysis of the obtained alloy and slag on a diffractometer was carried out. The presence of forsterite 2MgO · SiO<sub>2</sub> and magnesitochromite Cr<sub>2</sub>Fe<sub>0,2</sub>Mg<sub>0,8</sub>O<sub>4</sub> in the slag was revealed, as well as the FeCr compound and the absence of silicide compounds. The optimal percentage of replacing traditional coke with coal up to 30% (by weight) has been found, which can significantly reduce the specific consumption of quartzite in the charge.

**48. V. O. Ruban, O. M. Stoianov, Y. V. Synehin, I. Mamuzić**

**Analysis of the thermal performance of a graphitized hollow electrode.** An analysis of the process of heating a graphitized hollow electrode (GHE) during steel processing at the “ladle-furnace” unit was carried out. Coefficients of the heat transfer by convection have been calculated for the inner and outer GHE surface: 1,60 and 1,80, and 5–17 W/(m<sup>2</sup>·°C), respectively. Values of the electrode temperature gradient in the high-temperature zone were obtained, which, for the first heating period, reached 8,286 °C/m, for the third – to 6,571 °C/m. It was established that during the cooling periods of the electrode, the temperature gradient is significantly reduced and amounts to the inner surface of 379 °C/m; to the outer surface – 3,613 °C/m.

**49. I. Bondarenko, N. Serzhanova, Y. Kuldeev, N. Sadykov, A. Tastanova**

**Beneficiation of chrome slurry tailings at donskoy mining and beneficiation plant (DMBP) JSC to produce hard pellets.** The article is about the problem of beneficiation of finely dispersed chromium slurry tailings of “Donskoy Mining and Beneficiation Plant” JSC by chemical and gravitation methods. Chemical destruction of chromium spinelids by sulphation with a mixture of ammonium sulphate and sulphuric acid enables to transfer a part of magnesium oxide to a water-soluble state and further gravitation beneficiation on concentration tables to obtain a fine-grained rich chromium concentrate. Silica, calcium, and iron oxide additives are used to produce pellets from the fine chrome concentrate, serving as binding agents and enabling the production of hard chrome pellets during roasting. In the future, roasted pellets will be used in the smelting of high-carbon ferrochrome in electric furnaces.

**50. A. A. Mukhanova, A. M. Yessengazyev, M. B. Barmenshinova, N. O. Samenova, G. A. Toilanbay, K. N. Toktagulova**

**Improvement of the technology related gold-containing raw materials with the use of ultramicroheterogeneous floateragent.** The material composition of the gold-containing tailings of the flotation beneficiation of the Zholymbet ore deposit was studied. It was determined that the samples contain 0,9 g/t of gold, 1,22 g/t of silver. The flotation technologies of technogenic gold-containing raw materials with the use of basic and ultramicroheterogeneous flotation reagents were developed. The content of gold in a draft gold concentrate, in comparison with the basic mode, increases by 2,28 g/t - with 19,56 to 21,84 g/t. The extraction of gold in concentrate increased - by 5,52 % - with 66,07 % to 71,59 %. Thus the consumption of collectors is cut for 50 g/t, with 130 to 80 g/t.

**51. V. S. Mameshyn, K. H. Niziaiev, S. V. Zhuravlova, I. Mamuzić**

**The use of rheoscopic fluid in the study of metallurgical processes.** The document presents the studies results of possibility of using the rheoscopic fluid in the “cold” modeling in steelmaking processes. It is proposed to use a rheoscopic fluid containing 0.4 % of pearl pigment. It has been established that the use of rheoscopic fluid allows to visualize the movement of hydrodynamic flows in “cold” blowing modeling.

**52. Ye. Mukhambetgaliyev**

**Research of electrical resistance and temperature of the beginning of softening of charge mixtures for smelting a complex alloy.** The results of the study of the electrical resistance and the temperature of the beginning of softening of high-ash coals of three working seams of the Saryadyr deposit and mixtures of charge materials are presented. The high electrical resistance of the charge in the ore smelting furnace provides a low proportion of charge conductivity and, thereby, contributes to the release of the bulk of the energy in the reaction zone of the furnace, where the metal is formed. The research results showed that the magnitude of the electrical resistance of the charge during non-isothermal heating to high temperatures largely depends on the chemical and mineralogical composition of the charge, as well as on the processes of phase transformations in the sample.

**53. A. Khabiyeu, O. Baigenzhenov, Zh. Korganbayeva, A. Toishybek, T. Chepushtanova, B. Orynbayev**

**Niobium(v) recovery from leaching solution of titanium wastes: kinetic studies.** This paper deals with the removal of Nb content from chemically leached solutions of titanium wastes using static ion exchange technology. The chemically leached solutions contained 2 g/L of Nb. The investigations involved the optimization of process parameters, such as contact time at different concentrations of niobium at room temperature. Sorption experiments are performed to evaluate the optimum conditions at a concentration of HCl 3,0 M, 1,0 g resin dose for 3,5 h contact time at room temperature. The maximum sorption capacity reaches to 0,089 g/g. Kinetics studies were proposed for the process by pseudo-first-order, pseudo-second-order, and intra-particle diffusion models.

**54. A. Abdirashit, Ye. Makhambetov, T. Tushiyev, A. Nurumgaliyev, S. Smailov**

**Thermodynamics of integrated deoxidation of steel with a new alloy of aluminum-silicium-manganese (Al - Si - Mn).** The article considers the issue of using a complex alloy of aluminosilicomanganese as a deoxidizer. The value of the Wagner parameter of steel interaction - silicon, aluminum, manganese and concentration in the liquid, were associated with their activity in the metal. A certain consumption of the deoxidizer - aluminosilicomanganese per ton of liquid steel to improve the residual oxygen content in the metal. Possible generators of non-metallic inclusions are established.

**55. L. I. Solonenko, S. I. Repiakh, K. I. Uzlov, I. Mamuzić**

**Sand-sodium-silicate mixtures steam-microwave structuring technological peculiarities.** Steam-microwave structured sand-sodium-silicate mixtures highest technological properties have been obtained under conditions if they are initially in free-flowing state, used sand is mainly fractions of 0,16 ... 0,20 mm and, after cladding with sodium silicate solute, sieved through sieve with 0,315 mm mesh. For structuring, water steam should be fed into mixture as water charges. Their location in rigging allows the water steam, released from them, to move in direction from rigging dead-end parts to mixture open surface. Water mass single water charge is 1 ... 3 g of water per 2,5 kg of mixture. When structuring, do not allow interruption of microwave radiation influence on mixture for more than 20 ... 30 seconds before it ends.