

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)

**23. P. O. Shcherbyna, I. Mamuzić, G. G. Shvachych**

**Performance analysis of the interface of a pair pcie system based on channel aggregation.** The influence of changing the structural association of elements of the network interface of a multiprocessor computing system to improve its performance by aggregating channels of the PCIe interface adapted to the solution of the studied class of problems has been studied. The approach made it possible to increase the efficiency of parallelization and significantly reduce the computation time. These results were achieved by reducing the time of edge data exchange between the PCIe interface of the paired aggregation system module and the high-speed network adapter. The developed multiprocessor system is used to create new technological processes. It is used in the installation for the intensification of spheroidizing annealing of long steel products.

**24. I. Laktionov, I. Mamuzić, G. Shvachych, T. Karpova**

**On the problem of innovative blockchain technology application.** The carried out studies aimed at eliminating the identified knowledge gap between the potential areas of blockchain technology application and the required configuration of the entity's resources. It is demonstrated that the innovative blockchain technology is still in its infancy, and some researchers still have it with a certain degree of mistrust. Nevertheless, among the features of its application and its inherent features, one can identify a serious potential that eliminates the available level of mistrust. It is shown that the technology allows an enterprise to use blockchain as an effective resource for solving production problems. Additionally, it is emphasized that the major processes of choosing a blockchain as technology should be aimed at comprehending that it is best suited for solving the specific problem.

**25. A. K. Koizhanova, D. R. Magomedov, E. A. Tastanov, B. K. Kenzhaliyev, G. V. Sedelnikova, A. N. Berkinbayeva**

**Intensification of copper leaching from heaps using biological oxidation.** The article presents the results of experiments intended to leach copper from ore heaps of complex mineral composition biochemically. The processing of such heaps is complicated due to the presence of oxidized copper minerals among significant fragments of sulfide minerals and iron-calcium silicates. This factor does not allow to perform standard sulfuric acid leaching effectively without the use of additional oxidation catalysts, or to apply beneficiation methods for that kind of raw materials. Use of *A. Ferrooxidans* bacteria adapted to the composition of the copper dump, as a bio-catalytic agent, significantly accelerates the leaching process and increases the copper recovery degree into the productive solution.

**26. A. Shyrin, I. Mamuzić, G. Shvachych, M.M. Khylo**

**Research of some features of the distributed data registry technology.** The paper highlights the most intensively developing digital economy component, i.e., distributed ledger technology (blockchain). The paper shows that blockchain technology, as a decentralized data registry, is the most discussed and relevant topic in the development of the digital economy. There analyzed the strengths of the technology: cost reduction, high level of security, and transaction transparency. Those qualities draw the focus of various sectors of the economy. The proposed approach to the issue research allowed noting that the digital economy has several subtleties associated with insufficient knowledge, its flexibility, and various problems of technical implementation.

**27. G. G. Shvachych, I. Mamuzić, P. O. Shcherbyna**

**New technological developments based on the application of multiprocessor systems.** Research is aimed at improving existing and creating fundamentally new technological processes. In metallurgy, the heat treatment of metal requires expenses, which are explained by a significant number of full-scale experiments carried out in laboratory, pilot-industrial conditions, at production facilities. By using multiprocessor computing systems, it is possible to reduce the number of experimental studies and the time for their implementation. Consequently, the use of modern multiprocessor computer technologies makes it possible to effectively control technological processes. The technological process of metal processing acquires such advantages as high productivity, significantly reduced energy consumption and allows you to control technological parameters in the required modes of metal processing.

**28. K. Łakomy, T. Lis**

**Copper production and trade in Poland during the COVID-19 epidemic.** The SARS-CoV-2 virus outbreak has created turmoil in domestic economies around the world. The changes are visible in all industrial branches of the economy, including the market of metallic raw materials. The article reviews and analyzes the size of changes in the production and sales of copper and copper products in Poland in 2020, comparing the data in the previous years. The aim of the article is to assess the possible impact of the epidemic and related economic changes on the copper market in Poland.

**29. A. M. Dolzhanskiy, N. A. Bibik, I. Mamuzić**

**Assembly quality of hydraulic drive parts of mechanisms providing.** Some of the main parts of the plane chassis hydraulic drive are the hydraulic cylinder and the rod. In particular, in the manufacture of hydraulic cylinders for the chassis of the aircraft An 140 use seamless cold-drawn pipes made of steel St52. The rod is made of a calibrated steel bar of appropriate diameter with a chrome coating. The analysis of the chassis assembly technology of the An 140 aircraft allowed to determine the control points at which the quality of manufacturing and assembly of hydraulic drive parts is ensured, and to assess the adequacy of the technical control means used. On this basis, the Program of internal audit of the relevant technological processes of manufacture and use of components has been developed.

**30. I. Mamuzić, M. I. Khylo, A. Shyrin, D. Moroz**

**Research of the main principles of real options development.** The paper highlights the fundamental features of the option technologies development as one of the most essential components of the digital economy. It is shown that a real option allows making flexible decisions in conditions of uncertainty. Therefore, the analysis of real options as the most flexible and practical financial instrument of the digital economy was carried out. Furthermore, the conducted research reveals the essence of the main provisions of tactics and strategies in solving the problem of options pricing. Meanwhile, a new authors' classification of options contracts is presented, which allows determining their application, usage, and development. At the same time, the problem analysis of evaluation of the options contracts' price demonstrated the relevance of the new mathematical methods development for their reliable and accurate assessment.

**31. J. Furman, T. Małysa**

**Autonomous maintenance (AM) in the aspect of improvement work safety in the steel sector in Poland.** Autonomous maintenance is one of the important solutions used in industrial companies where part of the tasks related to the operation of machines is transferred to operators. In the steel sector in Poland, accidents related to the operation of technological machines are still reported. Given the above, this article lists the activities of machine operators in terms of methods and tools that allow for a reduction of the number of accidents at work. It aims to show the significance of the adoption of technical and organizational solutions directed at improving the safety of operators within AM in the steel sector in Poland.

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

**Environmentally friendly molds and cores - waste-free raw materials for silicate-block and sodium silicate solute production.** Sand mixtures with sodium silicate solute structuring method of steam-microwave solidification (SMS-process) makes it possible for 2..20 minutes to produce sand-sodium-silicate casting molds and cores with compressive strength up to 4.5 MPa and gas-generating capacity of 3 ... 7 cm<sup>3</sup>/g. Mixtures consist exclusively of quartz sand and sodium silicate solute. Molding has been carried out by filling of rigging with dry sand-sodium-silicate mixture and sealing it with vibration. Mixture from castings has been removed as result of shock-vibration or water-jet action on them. Such mixture waste cannot be regenerated, but can be used as raw material for silicate-block, sodium silicate solute production or as part of concrete products, as road surfacing, etc.

**33. O. S. Maksakova, A. M. Dolzhanskiy, I. Mamuzić**

**Prospects for the textile industry standardization development.** It is possible to develop the Ukrainian market of textile products by modernizing the means of production using the modern technologies and with the use of the higher level of modern regulatory documentation. The conducted analysis showed that in general, of 234 standards that had been developed by the International standardization organization, in particular, by the ISO/TC 38 «Textiles» the European Committee for Standardization has adopted about 60 % of ISO standards; about 52,5 % of them have been adopted by Ukraine, while 14 national regulations are harmonized with European standards that correspond to international ones. This determines the expedient vectors of further work in the specified field of activity.