

**Komitet za termodinamiku i fazne dijagrame Srbije**  
*u saradnji sa:*

Fakultetom tehničkih nauka u Kosovskoj Mitrovici,  
Tehničkim fakultetom u Boru i  
Associated Phase Diagram and Thermodynamics Committee  
(Poland, Czech Republic, Hungary, Bulgaria, Slovenia, Serbia,  
Montenegro, Romania, Croatia, Bosnia and Herzegovina)

**DVANAESTI SIMPOZIJUM O TERMODINAMICI  
I FAZNIM DIJAGRAMIMA**  
*sa međunarodnim učešćem*



**ZBORNİK IZVODA RADOVA**

**Kosovska Mitrovica,  
20-21. jun 2025. god.**

# Dvanaesti simpozijum o termodinamici i faznim dijagramima

## Izdavač:

Fakultet Tehničkih nauka  
Knjaza Miloša br.7, 38220 Kosovska  
Mitrovica  
Tel/Fax: (+381 28) 425-320 / 425-322  
office@ftn.pr.ac.rs



## Za izdavača:

**Dekan,**  
Prof. dr Jordan Radosavljević

## Urednik:

Prof. dr Duško Minić

## Kompjuterska obrada:

Doc. dr Aleksandar Đorđević  
Prof. dr Milena Zečević

## Godina izdavanja:

2025

## Tiraž: 100 primeraka

ISBN: 978-86-81656-84-6

Štampa: Grafit Raška

Na osnovu člana 55. stav. 1. tačke 8. i 38. Statuta Fakulteta tehničkih nauka u Kosovskoj Mitrovici, Nastavno-naučno veće na svojoj sednici održanoj dana 22.01.2025. godine, donelo je ODLUKU br. 44/3-10 o organizovanju naučnog skupa u 2025. godini, pod naslovom: „Dvanaesti simpozijum o termodinamici i faznim dijagramima“.





Simpozijum je finansijski podržan od strane  
Ministrastva nauke, tehnološkog razvoja i  
inovacija Republike Srbije



# Dvanaesti simpozijum o termodinamici i faznim dijagramima

## Naučni odbor

**Prof. dr D. Minić**, (University of Priština, Faculty of Technical Sciences, Kosovska Mitrovica, Serbia) predsednik naučnog odbora,

**Prof. dr M. Zečević**, (University of Priština, Faculty of Technical Sciences, Kosovska Mitrovica, Serbia)

**Prof. dr D. Manasijević**, (University of Belgrade, Technical Faculty in Bor, Serbia)

**Prof. dr Y. Du**, (Research Institute for Powder Metallurgy, Central South University, China)

**Prof. dr G. Kaptay**, (Research Institute for Nanotechnology BAYNANO, Hungary)

**Prof. dr J. Medved**, (University of Ljubljana, Faculty of Natural Science and Engineering, Slovenia)

**Prof. dr A. Udovsky**, Federal State Institution of Science, Baikov Institute of Metallurgy and Materials Science, Russia

**Doc. dr T. Holjevac Grgurić**, (University of Zagreb, Faculty of Metallurgy Sisak, Croatia)

**Prof. dr D. Blečić**, (University of Montenegro, Faculty of Metallurgy and Technology, Montenegro)

**dr V. Čosović**, (University of Belgrade, Institute of Chemistry, Technology and Metallurgy, Serbia)

**dr N. Talijan**, (University of Belgrade, Institute of Chemistry, Technology and Metallurgy, Serbia)

**Prof. dr N. Štrbac**, (University of Belgrade, Technical Faculty in Bor, Serbia)

**dr A. Kostov**, (Mining and Metallurgy Institute, Bor, Serbia)

**dr M. Sokić**, (University of Belgrade, ITNMS, Serbia)

**dr B. Marković**, (University of Belgrade, ITNMS, Serbia)

## Organizacioni odbor

**Doc. dr A. Đorđević**, (University of Priština, Faculty of Technical Sciences, Kosovska Mitrovica, Serbia) – Predsednik organizacionog odbora

**Prof. dr D. Minić**, (University of Priština, Faculty of Technical Sciences, Kosovska Mitrovica, Serbia)

**Prof. dr M. Zečević**, (University of Priština, Faculty of Technical Sciences, Kosovska Mitrovica, Serbia)

**Prof. dr D. Manasijević**, (University of Belgrade, Technical Faculty in Bor, Serbia)

**Doc. dr Lj. Balanović**, (University of Belgrade, Technical Faculty in Bor, Serbia)

**dipl. inž. J. Petrović**, (University of Belgrade, Technical Faculty in Bor, Serbia)

**dipl. inž. K. Božinović**, (University of Belgrade, Technical Faculty in Bor, Serbia)

## **Recenzentski odbor**

**Prof. dr D. Minić**, (University of Priština, Faculty of Technical Sciences, Kosovska Mitrovica, Serbia)

**Prof. dr M. Zečević**, (University of Priština, Faculty of Technical Sciences, Kosovska Mitrovica, Serbia)

**Prof. dr D. Manasijević**, (University of Belgrade, Technical Faculty in Bor, Serbia)

**Prof. dr Y. Du**, (Research Institute for Powder Metallurgy, Central South University, China)

**Doc. dr Lj. Balanović**, (University of Belgrade, Technical Faculty in Bor, Serbia)

# Sadržaj

	Dragan Manasijević, Duško Minić, Milena Zečević	
1.	<i>O aktivnostima Komiteta za termodinamiku i fazne dijagrame Srbije u proteklom periodu</i>	1
2.	<i>Trenutni članovi Komiteta za termodinamiku i fazne dijagrame Srbije</i>	4
3.	<i>Spisak objavljenih radova u časopisima međunarodnog značaja članova Komiteta za termodinamiku i fazne dijagrame Srbije u periodu 2024-2025. godina</i>	5

## Plenarno predavanje:

	Dragan Manasijević, Ljubiša Balanović, Ivana Marković, Milan Gorgievski, Uroš Stamenković, Avram Kovačević	
1.	<i>Al-Sn alloys as composite phase change materials for thermal energy storage: microstructural and thermal characterization</i>	11

## Izvodi radova:

	Dragan Manasijević, Ljubiša Balanović, Nicanor Cimpoesu, Ivana Marković, Milan Gorgievski, Uroš Stamenković, Aleksandra Stepanović	
1.	<i>Microstructural and thermal properties of the Al-Cu eutectic alloy</i>	15
	Kristina Božinović, Dragan Manasijević, Ljubiša Balanović, Ivana Marković, Milan Gorgievski, Uroš Stamenković, Miljan Marković	
2.	<i>Microstructural and thermal characterization of some alloys from the ternary Ag-In-Sn system</i>	17
	Milan Nedeljković, Srba Mladenović, Vladan Čosović, Ivana Marković, Jasmina Petrović, Uroš Stamenković, Milijana Mitrović, Avram Kovačević	
3.	<i>Thermal properties of eutectic Sn-0.7Cu alloy reinforced with graphene nanosheets produced by powder metallurgy technique</i>	19
	Milan Gorgievski, Miljan Marković, Nada Štrbac, Dragan Manasijević, Vesna Grekulović, Dalibor Jovanović, Marina Marković	
4.	<i>Kinetic and DTA-TGA analysis of Cu<sup>2+</sup> biosorption on hazelnut shells</i>	21
	Marina Marković, Milan Gorgievski, Miljan Marković, Nada Štrbac, Vesna Grekulović, Milica Zdravković, Nemanja Milošević	
5.	<i>DTA-TGA and thermodynamic studies of walnut shells used for the biosorption of Cu<sup>2+</sup> ions from synthetic solutions</i>	23
	Uroš Stamenković, Ivana Marković, Dragan Manasijević, Vladan Čosović, Milan Gorgievski, Avram Kovačević, Milan Nedeljković	
6.	<i>Melting temperatures and thermal properties of Sn-Bi alloys and composites</i>	25

7.	Uroš Stamenković, Ivana Marković, Milan Nedeljković, Kristina Božinović <b><i>Wetting behavior of Sn-Bi solder alloy and composites obtained by powder metallurgy</i></b>	27
8.	Ivana Marković, Milica Volojanović, Uroš Stamenković, Dragan Manasijević, Milan Nedeljković, Ljubiša Balanović <b><i>Microstructure of Sn-Ag-Cu Composites: Sintered State and Post-Soldering Analysis</i></b>	29
9.	Milijana Mitrović, Saša Marjanović, Biserka Trumić, Vesna Krstić, Milan Nedeljković, Jasmina Petrović <b><i>Influence of extrusion process on the comminution of the microalloyed Cu-Fe-P alloy structure</i></b>	31
10.	Jasmina Petrović, Srba Mladenović, Milan Nedeljković, Ivana Marković, Uroš Stamenković, Milijana Mitrović <b><i>Microstructure and potential of hybrid aluminum composites based on EN AW-6061 reinforced with Al<sub>2</sub>O<sub>3</sub> and walnut shell ash</i></b>	33
11.	Jasmina Petrović, Srba Mladenović, Milan Nedeljković, Ivana Marković, Milijana Mitrović, Aleksandra Ivanović <b><i>Protective role of gelatin in corrosion resistance of cold-formed copper wire</i></b>	35
12.	Avram Kovačević, Uroš Stamenković, Milan Nedeljković <b><i>Review of material and process parameters in the production of drawn SnPb wire</i></b>	37
13.	Milan T. Đorđević, Aleksandar Todić, Aleksandar Đorđević <b><i>Experimental device for investigations of tribological influences in sheet metal forming</i></b>	39
14.	Aleksandar Todić, Milan T. Đorđević, Dušan Arsić, Aleksandar Đorđević <b><i>The influence of vanadium on the microstructure and electrochemical properties of carbides in chromium-molybdenum steels</i></b>	41
15.	Veljko Minić, Miljana Popović, Milena Zečević, Jelena Miladinović, Aleksandar Đorđević <b><i>Experimental results of phase transition temperatures of the Al-Bi-Ge ternary alloys</i></b>	43
16.	Aleksandar Đorđević, Duško Minić, Yong Du, Milena Zečević <b><i>Electrical conductivity of the Al-Bi-Ge alloys</i></b>	45
17.	Duško Minić, Dejan Gurešić, Yuling Liu, Milena Zečević <b><i>Brinell hardness of the Al-Bi-Ge alloys</i></b>	47
18.	Milena Zečević, Duško Minić, Aleksandar Đorđević, Veljko Minić <b><i>Experimental test of as-cast samples from the Al-Bi-Ge ternary system</i></b>	49
19.	Veljko Minić, Aleksandar Đorđević, Yuling Liu, Duško Minić, Milena Zečević <b><i>Experimental test of phase equilibria of the Al-Bi-Ge ternary system at 400 °C</i></b>	51
20.	Jovana Galjak, Miljana Krstić, Ivan Bogavac, Svetomir Milojević, Gordana Milentijević <b><i>Characterization of coal fly ash for the production of coagulant for usage in wastewater treatment</i></b>	53

21.	Miljana Krstić, Svetomir Milojević, Jelena Avramović, Ana Veličković, Jovana Galjak, Vlada Veljković <b><i>Temporal Fractionation and Modeling of Juniper Berry Oil Composition During Hydrodistillation</i></b>	55
22.	Irma Dervišević, Jelena Đokić <b><i>Bioremediation of plastic by microbiomes and its conversion into biopolymers</i></b>	57
23.	Mladen Šljivić, Miljojka Mijailović, Svetomir Milojević, Jovana Galjak, Miljana Krstić <b><i>Obtaining distillate from the Leskovac quince variety</i></b>	59
24.	Ljiljana Babincev, Jovana Kulizić, Anđela Babincev <b><i>Thermodynamic Analysis of Diastase Enzyme Degradation in Different Types of Honey</i></b>	61
25.	Jelena Đokić, Jasmina Dedić, Irma Dervišević <b><i>Environmental Impact Assessment of the REE at the area Contaminated with Lead Metallurgy Waste Deposit</i></b>	63
26.	Jelena Đokić, Jasmina Dedić, Irma Dervišević <b><i>The impact of gauge minerals Feldspar and Diopside Ferroan on heavy metals and REE penetration to the soil</i></b>	65
27.	Dimitrije Anđić, Miroslav Sokić, Aleksandar Jovanović, Branislav Marković, Vaso Manojlović, Željko Kamberović <b><i>Thermal decomposition of cerussite</i></b>	67
28.	Gvozden Jovanović, Dimitrije Anđić, Dragana Randelović, Danijela Smiljanić, Branislav Marković, Miroslav Sokić <b><i>Application of Thermogravimetric analysis on combustion study of biomass for Zn extraction</i></b>	69
29.	Gordana Marković, Vaso Manojlović, Francisco Javier Dominguez Gutierrez, Karol Frydrych <b><i>Phase Diagram Analysis of Ti-Mo-Sn System for <math>\beta</math>-Titanium Alloy Development</i></b>	71

## **Melting temperatures and thermal properties of Sn-Bi alloys and composites**

**Uroš Stamenković<sup>1a</sup>, Ivana Marković<sup>1b</sup>, Dragan Manasijević<sup>1c</sup>, Vladan Čosović<sup>2a</sup>, Milan Gorgievski<sup>1d</sup>, Avram Kovačević<sup>1e</sup>, Milan Nedeljković<sup>1f</sup>**

<sup>1</sup> *Technical Faculty Bor, University of Belgrade, V.J. 12, 19210 Bor, Serbia*

<sup>2</sup> *University of Belgrade, Institute of Chemistry, Technology and Metallurgy, Belgrade, Serbia*

<sup>1a</sup> [ustamenkovic@tfbor.bg.ac.rs](mailto:ustamenkovic@tfbor.bg.ac.rs), 0000-0002-7579-2159

<sup>1b</sup> [imarkovic@tfbor.bg.ac.rs](mailto:imarkovic@tfbor.bg.ac.rs), 0000-0003-4431-9921

<sup>1c</sup> [dmanasijevic@tfbor.bg.ac.rs](mailto:dmanasijevic@tfbor.bg.ac.rs), 0000-0002-7828-8994

<sup>2a</sup> [vlada@tmf.bg.ac.rs](mailto:vlada@tmf.bg.ac.rs), 0000-0001-7644-4036

<sup>1d</sup> [mgorgievski@tfbor.bg.ac.rs](mailto:mgorgievski@tfbor.bg.ac.rs), 0000-0002-9899-719X

<sup>1e</sup> [akovacevic@tbor.bg.ac.rs](mailto:akovacevic@tbor.bg.ac.rs), 0000-0003-4009-4876

<sup>1f</sup> [mnedeljkovic@tfbor.bg.ac.rs](mailto:mnedeljkovic@tfbor.bg.ac.rs), 0000-0002-7927-1334

### **Abstract**

This study investigates the melting temperatures and thermal properties of tin-bismuth (Sn-Bi) alloys and their composites. The investigation involved the preparation of pure tin, two alloys (SnBi12 and SnBi21, by weight percentage), and two composites (SnBi12 + 0.2 wt.% Cu and SnBi12 + 0.2 wt.% C) through casting. The pure metals were melted in a graphite crucible at 400 °C for 20 minutes, followed by mechanical stirring. During stirring, 0.2 wt.% of pure carbon powder (with a particle size of less than 45 μm) and pure copper powder (also with a particle size of less than 45 μm) were added separately to the SnBi12 melt to create the two different composites. After melting and stirring, the mixture was cast in a steel mold. Samples were extracted from the cast ingots for differential thermal analysis (DTA) to determine the melting temperatures of the investigated samples. Additionally, samples were prepared to assess thermal diffusivity, thermal conductivity, and specific heat using the Xenon flash method at room temperature. The DTA analysis revealed that the melting temperature was the highest for the pure tin sample. The addition of bismuth reduced the melting temperature from 237.43 °C for pure tin to 222.59 °C for SnBi12 and 211.35 °C for SnBi21. The melting temperatures of the SnBi12 + Cu and SnBi12 + C composites were nearly identical to that of the SnBi12 alloy, indicating that the dispersed particles did not influence the melting temperature. Furthermore, thermal diffusivity, thermal conductivity, and specific heat values were lower for the alloys compared to those of the pure tin sample. The composites also exhibited lower thermal diffusivity and thermal conductivity values compared to the SnBi12 alloy. In conclusion, bismuth affects both the melting temperature and the thermal properties of Sn-Bi alloys,

while Sn-Bi composites influence thermal properties without affecting the melting temperature of Sn-Bi alloys.

**Type of work:** original research paper.

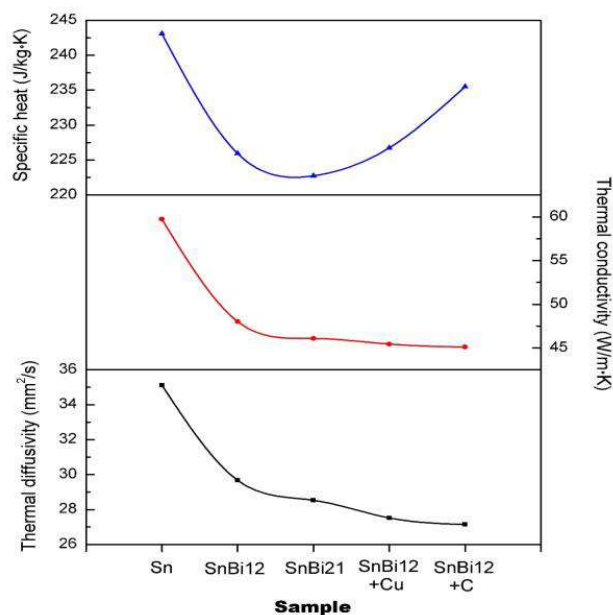
### **Acknowledgement**

The research presented in this paper was done with the financial support of the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, within the funding of the scientific research work at the University of Belgrade, Technical Faculty in Bor, according to the contract with registration number 451-03-137/2025-03/200131, and at the University of Belgrade, Institute of Chemistry, Technology and Metallurgy, Belgrade, Serbia according to the contract with registration number 451-03-136/2025-03/200026.

### **References**

1. Y.A. Shen, The Journal of The Minerals, Metals & Materials Society, 75 (2023) 4922-4930.
2. F. Wang, H. Chen, Y. Huang, L. Liu, Z. Zhang, Journal of Materials Science: Materials in Electronics, 30 (2019) 3222–3243.
3. W. Firdaus, B. Soegijono, A. Sudarmadji, A.D. Trisnadi, AIP Conference Proceedings, 1 June 2020, 2242 (2020) 020011.
4. Q. Wang, X. Cheng, X. Wang, T. Yang, Q. Cheng, Z. Liu, Z. Lv, Materials, 16 (2023) 5325.

### **Graphical abstract:**



*Different thermal properties of the investigated samples.*



CIP - Каталогизација у публикацији  
Народна библиотека Србије, Београд

669.017(048)  
536.7(048)

**СИМПОЗИЈУМ о термодинамици и фазним дијаграмима (12 ; 2025 ; Косовска Митровица)**

Zbornik izvoda radova / Dvanaesti simpozijum o termodinamici i faznim dijagramima sa međunarodnim učešćem, Kosovska Mitrovica, 20-21. jun 2025. god. ; [organizator] Komitet za termodinamiku i fazne dijagrame Srbije ... [et al.] ; [urednik Duško Minić]. - Kosovska Mitrovica : Fakultet tehničkih nauka, 2025 (Raška : Grafite). - 74 str. : ilustr. ; 25 cm

Tiraž 100.

ISBN 978-86-81656-84-6

a) Физичка металургија -- Апстракти b) Термодинамика -- Апстракти

COBISS.SR-ID 170393353