

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)

JEDANAESTI SIMPOZIJUM O TERMODINAMICI I FAZNIM DIJAGRAMIMA

sa međunarodnim učešćem



ZBORNIK IZVODA RADOVA

**Kosovska Mitrovica,
23-24. jun 2023. god.**

Jedanaesti simpozijum o termodinamici i faznim dijagramima

Izdavač:

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



Za izdavača:

Dekan,
Prof. dr Srđan Jović

Urednik:

Prof. dr Duško Minić

Kompjuterska obrada:

Doc. dr Aleksandar Đorđević

Godina izdavanja:

2023

Tiraž: 100 primeraka

ISBN: 978-86-81656-63-1

Štampa: SaTCIP d.o.o. Vrnjačka Banja

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 10.02.2023. godine, donelo je ODLUKU br. 126/3-8 o organizovanju naučnog skupa u 2023. godini, pod naslovom: „Jedanaesti simpozijum o termodinamici i faznim dijagramima“.



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

Jedanaesti simpozijum o termodinamici i faznim dijagramima

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Prof. dr M. Zečević, Srbija
Prof. dr D. Manasijević, Srbija
Prof. dr Y. Du, Kina
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Dr M. Sokić, Srbija
Dr B. Marković, Srbija

Organizacioni odbor

Doc. dr. A. Đorđević, predsednik
Prof. dr D. Minić,
Prof. dr M. Zečević,
Prof. dr D. Manasijević,
Doc. dr Lj. Balanović,
dipl. inž. J. Petrović
dipl. inž. M. Mitrović

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The influence of the obtaining procedure and thermomechanical treatment on the grain size of copper micro-alloyed with iron and phosphorus

**Milijana Mitrović¹, Saša Marjanović¹, Biserka Trumić², Jasmina Petrović¹,
Milan Nedeljković¹**

¹*University of Belgrade, Technical Faculty in Bor, VJ 12, Bor, Serbia*

²*Mining and Metallurgy Institute Bor, Bor, Serbia*

Abstract

The aim of this work was to analyze the influence of the obtaining procedure and thermomechanical treatment on the grain size of copper micro-alloyed with iron and phosphorus (0,003 wt%Fe and 0,014 wt%P). Microalloyed copper was obtained in two ways: by melting of cathode copper and prealloy CuFe0.1 and CuP6.42 in an induction furnace, which was followed by the casting; and melting of the same raw materials and casting with the "up-cast" process, which was followed by extrusion. Pure (cathode) copper was also obtained by casting in order to compare with micro-alloyed copper. The samples obtained in this way were subjected to thermomechanical processing, which involved cold plastic deformation by rolling with 50%, which was followed by annealing at 470°C for 50 min. Microstructural analysis of the prepared samples was performed using optical microscopy, and the average grain size and grain size distribution were determined using ImageJ software. The results show that the pure copper sample has the coarsest structure with an average grain size of 30.58 μm , the microalloyed copper obtained by melting in an induction furnace has a slightly finer grain of 27.86 μm , while the finest is in the sample obtained by "up-cast" and extrusion process with 20.33 μm . The micro-addition of iron had influence on the grain refinement, because it acts as an inhibitor of grain growth during deformation and heat treatment, while the addition of phosphorus improved the flowability and plastic processing of the examined material. The extrusion process has shown justification in terms of grain refinement, because the finer the grain before deformation, the finer the recrystallized grain will be. A smaller starting grain causes a higher accumulated energy and density of dislocations during deformation, so that conditions are created for the formation of nucleus in many more places inside the grain. The combination of extrusion and rolling not only reduced the grain size, but also reduced the heterogeneity of grain distribution in the tested sample.



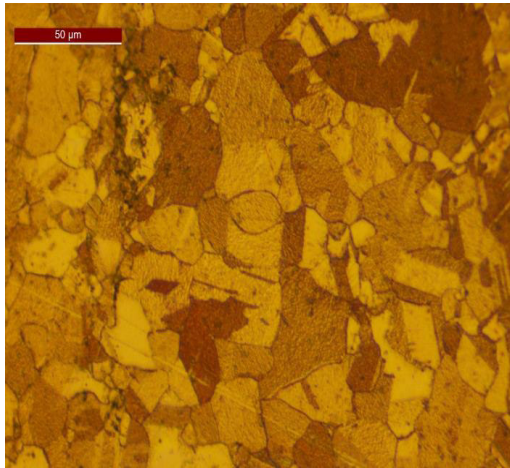
Acknowledgement

The research presented in this paper was done with the financial support of the Ministry of Education, Science and Technological Development 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 451-03-47/2023-01/ 200131.

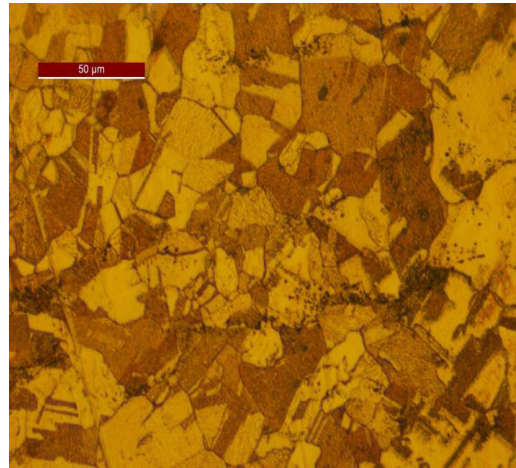
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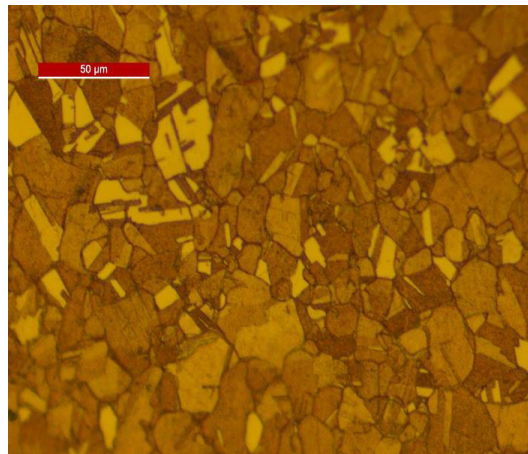
Graphical abstract:



a)

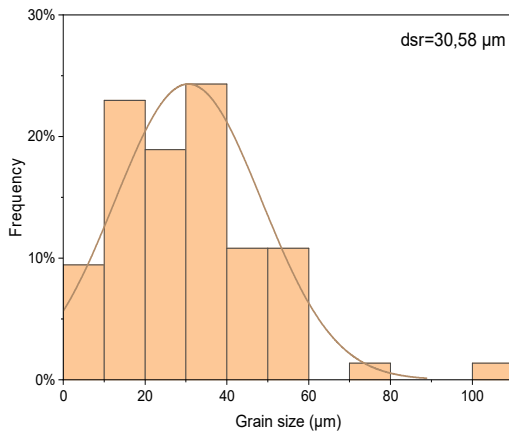


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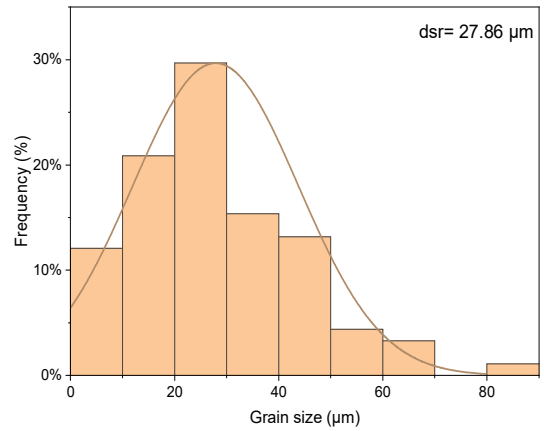


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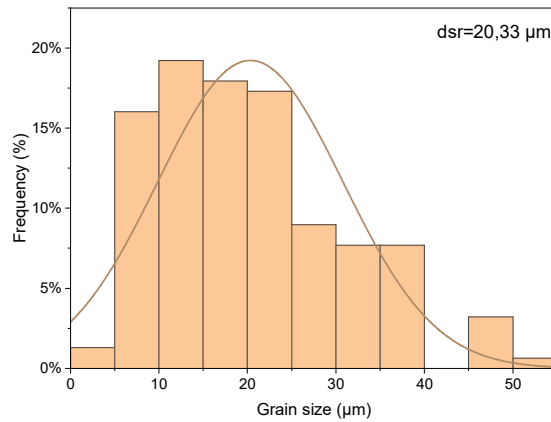
Optical microphotographs of recrystallized structures after annealing at 470°C for 50 min: a) pure copper, 500x, b) micro-alloyed copper obtained by melting in an induction furnace, 500x and c) micro-alloyed copper obtained by "up-cast" casting and extrusion, 500x.



a)



b)



c)

Mean grain size d_{sr} and grain size distribution for samples with a degree of deformation of 50% annealed for 50 min at a temperature of 470°C: a) pure copper, b) micro-alloyed copper obtained by melting in an induction furnace and c) micro-alloyed copper obtained by "up-cast" casting and extrusion.