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Technical Faculty in Bor and
Mining and Metallurgy Institute Bor

49th International October Conference on Mining and Metallurgy

PROCEEDINGS

Editors:
Nada Štrbac
Ivana Marković
Ljubiša Balanović

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PROCEEDINGS,
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on Mining and Metallurgy

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PREFACE

On behalf of the Organizing Committee, it is a great honor and pleasure to wish all the participants a warm welcome to the 49th International October Conference on Mining and Metallurgy (IOC 2017) held at Bor Lake, Serbia, 18 – 21 October 2017.

The IOC 2017 has been organized by the University of Belgrade, Technical Faculty in Bor, in cooperation with Mining and Metallurgy Institute Bor. It is devoted to presenting recent research results and advances in the fields of geology, mining, metallurgy, materials science, technology, environmental protection, and related engineering topics. The primary goal of IOC is to bring together academics, researchers, and industry engineers to exchange their experiences, expertise and ideas, and also to consider possibilities for collaborative research.

This year's conference is dedicated to the memory of Professor Dragana Zivkovic who was one of our most loyal and active Committee members. The 4th International Student Conference on Technical Sciences (ISC 2017) will take place within the frame of IOC 2017. ISC provides a unique opportunity for the students from both the country and the region to promote scientific research and discuss future directions of research with the experts and specialists.

These proceedings include 153 papers from authors coming from universities, research institutes and industries in 30 countries: Austria, Bosnia and Herzegovina, Bulgaria, China, Croatia, Czech Republic, France, Germany, Hungary, India, Iran, Italy, Japan, Jordan, Kazakhstan, Libya, Macedonia, México, Montenegro, Norway, Poland, Romania, Russia, Slovakia, Slovenia, South Africa, Spain, Turkey, USA and Serbia.

Financial assistance provided by the Ministry of Education, Science and Technological Development of the Republic of Serbia is gratefully acknowledged. The support of the sponsors and their willingness and ability to cooperate has been of great importance for the success of IOC 2017. The Organizing Committee would like to extend their appreciation and gratitude to all the sponsors and friends of the Conference for their donations and support.

We would like to thank all the authors who have contributed to these proceedings, and also to the members of the scientific and organizing committees, reviewers, speakers, chairpersons and all the Conference participants for their support to IOC 2017. Sincere thanks to all the people who have contributed to the successful organization of IOC 2017.

We look forward to welcoming you to the 50th International October Conference on Mining and Metallurgy (IOC 2018), which will be held in October 2018.

On behalf of the 49th IOC Organizing Committee,

Assistant Professor Ivana Marković, PhD

IN MEMORIAM

Prof. dr Dragana Živković
(13th September 1965 – 26th November 2016)

Dragana Živković, a full professor and the dean at the Technical Faculty in Bor, University of Belgrade and a full member of the Academy of Engineering Sciences of Serbia, gave an immeasurable contribution to the development of science and education in the fields of thermodynamics, metallurgical engineering and materials science. She left a deep trace, unique in its nature, not only in Serbia, but also in the world.

Dragana Živković was one of the leading scientists in the field of Thermodynamics of multicomponent metallic systems, Advanced metallic materials, Metallurgy of iron and steel, Kinetics of metallurgical processes and Archaeometallurgy. She published over 200 scientific papers in international SCI journals, over 150 papers in national journals and more than 500 conference papers. Her papers have been cited more than 500 times.

She was involved in about 40 projects, about half of them being international, many of which were coordinated by Dragana herself. She was a member of numerous international and national scientific and professional organizations and associations, the editor-in-chief of Journal of Mining and Metallurgy, Section B: Metallurgy, a member of editorial boards of several international and national journals, the secretary of the Committee of thermodynamics and phase diagrams of Serbia, and the chairman and a member of the scientific and organizing committees of numerous national and international scientific conferences.

Through her continual participation at the International October Conference on Mining and Metallurgy, as an author, as a member of the organizing committee and the president of the scientific committee on several occasions, she managed to make this conference distinguishable in wider scientific circles, connecting people through successful collaboration and lasting friendships.

She was our dear friend, a valued and generous colleague and an inspiring teacher. She touched all of us with her positive attitude, dedication, generosity and friendship.

For all of us who had the privilege to know her, she will always be the part of our lives.

The 49th IOC Organizing Committee

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THE INFLUENCE OF MECHANICAL ACTIVATION OF TALC- FILLER ON THE QUALITY OF THE REFRACTORY COATINGS

Marko Pavlović[1], Ljubiša Andrić[2], Dragan Radulović[2], Zoran Čeganjac[3]

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Abstract

For development of the refractory coatings with controlled rheologic properties, for application in new Lost Foam casting process, the influence of the mechanical activation on the talc-based filler's properties change was examined. The test referred to the change of filler particles' size and shape, as well as to dispersion ability and stability of the coating suspension. Optimization of the coating composition was attained chosing the right size and grain shape factor of the activated filler. In addition, different coating components were applied and the coating production procedure was altered. It was shown that application of this type of the water-based refractory coatings had a positive influence on surface quality, structure and mechanical properties of the aluminium alloy castings.

***Keywords**: talc-based filler; mechanical ativation; new refractory coatings*

1. INTRODUCTION

Composition and production procedures for the Lost Foam refractory coatings (LF refractory coatings) with a mechanically activated talc-based filler were planned together with reasearch activities referring to dependance of the castings structure and properties on the casting process parameters. The following parameters were analysed: casting temperature, mold permeability and design of the pattern and pouring systems [1-3]. The subject of reasearch was the corelation between these parameters and the polymer pattern density and the type and thickness of refractory coating layers. Unlike sand mold casting where liquid metal flows into the ''mold cavity", with the Lost Foam process, patterns and pouring systems made of polymers are retained in the mold until liquid metal has flown in ("full mold casting") [4-7]. In contact with liquid metal, polymer patterns degrade and evaporate; at the same time, castings solidification takes place. Pattern degradation and evaporation rate depends on polymer density, casting temperature, LF refractory coatings' permeability and sand mold permeability. This paper paid particular attention to these factors.

2. EXPERIMENTAL

2.1 Materials and Methods

Talc used in this work was produced through combined procedurs of preparing mineral raw materials (cruhng, leaching) of excavated talc whith a heterogenous chemical composition: 61.50% SiO_2; 29.45% MgO; 1.78% Al_2O_3; 2.84% Fe_2O_3; 2.50% CaO; 1.90% Na_2O+K_2O. Particular attention was paid to the talc purification procedure, as well as to reduction of the Fe_2O_3 and CaO content. For characterization of the talc samples, X-ray diffraction analysis was applied in the X-ray diffractometer PHILIPS, model PW-1710. The microstructure of the samples was characterized by scanning electron microscopy method (SEM) using a JOEL JSM-6390Lv microscope. Fig.1a. shows XRD of the talc samples before activation with dominant presence of talc in the initial sample with expressed intensities of diffraction peaks. Fig.1b. shows SEM microphotograph of the initial talc sample- before mechanical activation and it showed that this mineral was exclusively present in proper foliar aggregates.

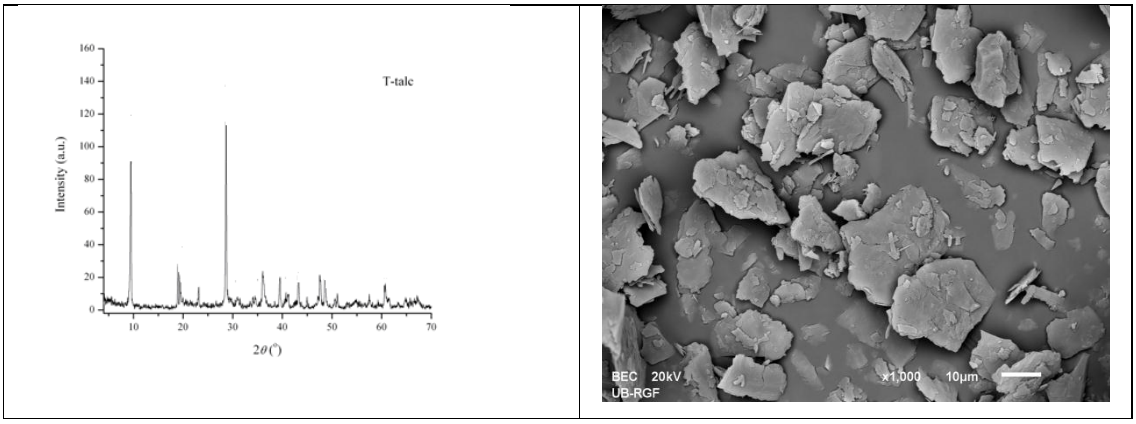


Figure 1 - Talc sample before activation: a. XRD of samples; b. SEM microphotograph of samples

The produced talc samples were milled in a ceramic ball mill down to upper limit grain size of 40 µm. It was the initial grain size of the filler T; it then underwent the mechanical activation process in a vibration mill over different times (min): 10; 20; 30; filler sample codes: T_1; T_2; T_3, respectively. Size and shape of a grain fillers are determined according to the program Ozaria 2.5. Fig.2a. shows XRD of the talc samples after activation (30 min). Diffraction peaks got less intense thus indicating alteration of microstructure, amorphousness of the material treated, change of the filler grain size and shape, as well as crystal defects. This was noticed while examining the structure of activated filler by means of the scanning electron microscopy, Fig.2b.

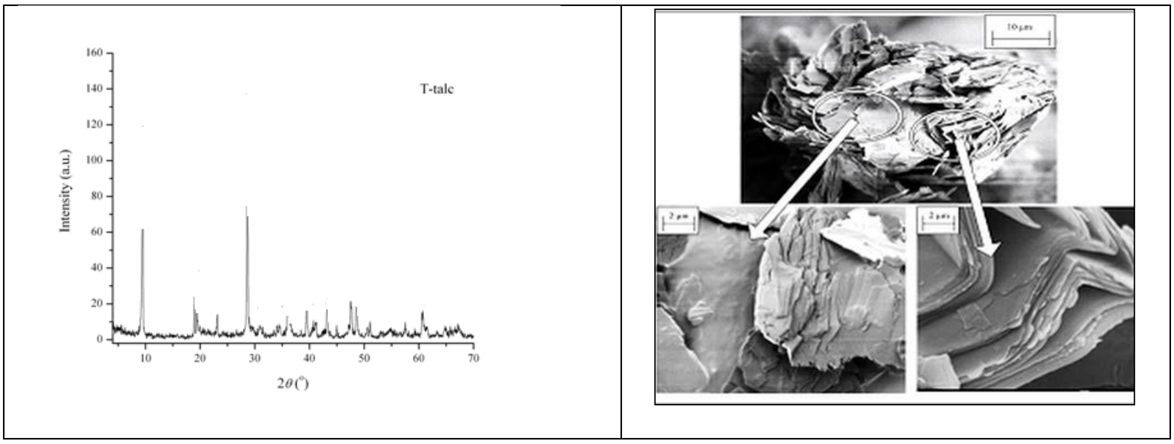


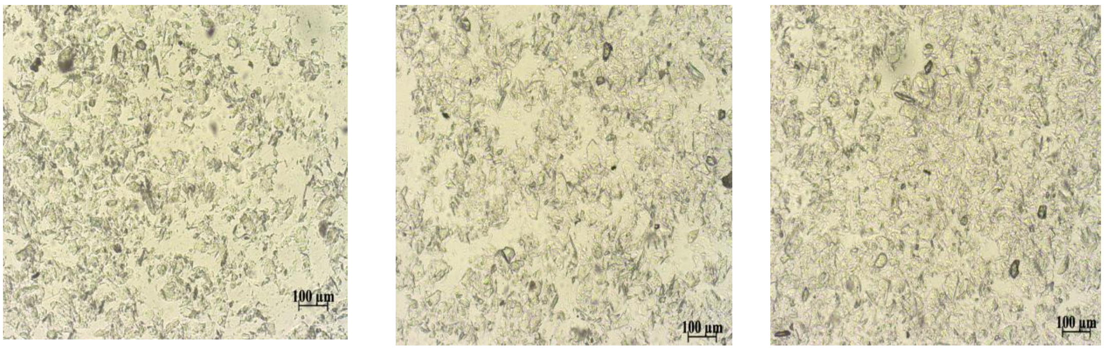
Figure 2 - Talc sample after activation: a. XRD of samples; b. SEM microphotograph of samples

3. RESULTS AND DISCUSSION

Depending on the time required for mechanical activation, the change of the filler grain size and shape was analysed together with its influence on the coating dispersion ability and stability. Talc samples produced after mechanical activation (coded: T_1; T_2; T_3) were used to produce both water and alcohol based refractory coatings, table 1, Fig.3. Research referring to refractory coating synthesis with the talc-based activated filler which were applied both in sand casting procedures (to coat sand molds and cores) and in the Lost Foam process (to coat polymer patterns) was carried out in compliance with domestic norms governing this type of refractory coatings [3,4] and with our earlier works from this field [2,6], as well as with the test results for the influence of mechanical activation on the talc structure and properties [5]. Refractory coating produced were tested at the temperature of 22º C [3,4]. Thickness of the wet coating film layers were (μm): 0.3; 0.6; 0.9. Refractory coatings were applied to polymer patterns through immersing and pouring procedures, while sand molds were coated by means of brushes. To assess the quality of the coatings obtained, simple, plate-shaped castings were casted from the alloy AlSi10CuMg.

Table 1 - Talc-based refractory coatings composition

Coating	***Type I***	***Type II***	***Type III***
Filler	T_2 , 22 μm, 84%	T_2 , 22 μm, 73% + T_3 , 10 μm, 10%	T_2 , 22 μm, 85%
Bonding agent	Bentonite 4.5 %; Bindal H 4.5 %	Bentonite 5 %; Bindal H 5 %	($C_{20}H_{30}O_2$) 3.5 % Dextrin 1 %
Additive	Suspension maintenance agent: Carboxymethyl cellulose (CMC), 1.5 %	Suspension maintenance agent: Carboxymethyl cellulose (CMC), 2 %	Bentone 25, 2.5 %; Phenol formaldehyde resins 0.5 %
Solvent	Water	Water	Isopropyl alcohol
Density(kg/m^3)	2000	2000	2000



a. LF coatings, Type I b. LF coatings, Type III c. Coating, Type III

Figure 3 - Microphoto of suspensions of the refractory coatings

During mechanical activation, the structure of the initial talc, Fig.1b, was changed, the talc grain was crushed and rounded, Fig.2b. After mechanical activation over different times (min): 10; 20; 30, the fillers with various sizes and forms were produced: T_1, 30 μm, mean grain shape factor 0.62; T_2, 22 μm, mean grain shape factor 0.69; T_3, 10 μm, mean grain shape factor 0.72, respectively. Based on the data on the filler mean grain size, it may be expected that the lower-grained fillers will precipitate slower in suspension; they will keep their dispersed state longer and the coating suspension will homogenize more easily. Sedimentation of coating (24h) were (%): 5.5 (Type I), 4,5 (Type II) and 5 (Type III).

4. CONCLUSION

The result of this reasearch is determination of the optimized compositions of the water-based Lost Foam refractory coatings with the mechanically activated, talc-based filler (with grain size from 10-22 μm). As for sand molds and cores, the composition of the alcohol-based refractory coatings with talc-based activated filler (with grain size of 22 μm) was defined. As activated talc-based fillers with a smaller grain size were applied, the compositions of coatings were altered in terms of content of binding agent and additive, which helped both improve sedimentary stability of coating suspension and utilization properties of the coatings. Preparation procedures for coating suspensions were defined to accomplish pre-defined coating properties in terms of refractoriness, gas permeability, easy application and adherence to mold and pattern surfaces, easy adjustment of the coat layer thickness, no bubbles, no cracking or erasure of the dried coat layers.

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