PHYSICS RESEARCH AND TECHNOLOGY

PROCEEDINGS OF THE 2018 INTERNATIONAL CONFERENCE ON "PHYSICS, MECHANICS OF NEW MATERIALS AND THEIR APPLICATIONS"

Ivan A. Parinov ⌘ *Shun-Hsyung Chang*
Yun-Hae Kim
Editors

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MATERIALS SCIENCE AND TECHNOLOGIES

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CONTENTS

PREFACE

Novel materials are very important for a whole set of prospective directions of modern science and techniques, defining the most interesting areas of modern technologies and industry. The developed conceptions, approaches and methods to study of advanced materials and composites initiate the main achievements and define possibilities of modern natural and technical sciences. Direct improvements of the characteristics of materials and devices are based on different chemical, physical and mechanical studies, methods of mathematical modeling and physical experiment. Broad set of applications determine constant and tremendous interest to these studies. Rapid growth of new knowledge and R&D of theoretical, experimental and numerical methods and approaches state the problem of continuous improvement of experimental facilities, and development of original computer hard- and software of higher level. Obviously, new scientific knowledge is based on the results of these researches, which give a possibility to understand and estimate very fine technological processes and transformations of structural-sensitive properties, taking place in manufacture of novel developed materials, composites and goods. These discoveries define optimal physical and mechanical loads and operation of devices in the conditions of critical impacts and fields.

This collection of 50 papers presents selected reports of the 2018 International Conference on "Physics, Mechanics of New Materials and Their Applications" (PHENMA-2018), which has been taken place in Busan, South Korea, 9-11 August, 2018 (http://phenma2018.math.sfedu.ru) The conference was sponsored by the Busan Tourism Organization (South Korea), Ministry of Education and Science of Russian Federation, South Scientific Center of Russian Academy of Science, Russian Foundation for Basic Research, Ministry of Science and Technology of Taiwan, The Korean Society of Ocean Engineering (South Korea), New Century Education Foundation (Taiwan), Ocean & Underwater Technology Association (Taiwan), Unity Opto Technology Co. (Taiwan), Fair Well Fishery Co. (Taiwan), Woen Jinn Harbor Engineering Co. (Taiwan), Lorom Group (Taiwan), Longwell Co. (Taiwan), University of 17 Agustus 1945 Surabaya

(Indonesia), University of 45, Surabaya (Indonesia), University of Islam Kadiri (Indonesia), University of Darul Ulum, Jombang (Indonesia), University of Maarif Hasyim Latif, Sidoarjo (Indonesia), PDPM Indian Institute of Information Technology, Design and Manufacturing (India), Don State Technical University (Russia), South Russian Regional Centre for Preparation and Implementation of International Projects.

The topics of the PHENMA-2018 continued ideas of previous international symposia and conferences: PMNM-2012 (http://pmnm.math.rsu.ru), PHENMA-2013 (http://phenma.math.sfedu.ru), PHENMA-2014 (http://phenma2014.math.sfedu.ru), PHENMA-2015 (http://phenma2015.math.sfedu.ru), PHENMA-2016 (http://phenma2016.math.sfedu.ru) and PHENMA-2017 (http://phenma2017.math.sfedu.ru), whose results have been published in the following edited books "Physics and Mechanics of New Materials and Their Applications", Ivan A. Parinov, Shun Hsyung-Chang (Eds.), Nova Science Publishers, New York, 2013, 444 p. ISBN: 978-1-62618-535-7; "Advanced Materials – Physics, Mechanics and Applications", Springer Proceedings in Physics. Vol. 152. Shun-Hsyung Chang, Ivan A. Parinov, Vitaly Yu. Topolov (Eds.), Springer, Heidelberg, New York, Dordrecht, London, 2014, 380 p. ISBN: 978-3319037486; "Advanced Materials – Studies and Applications", Ivan A. Parinov, Shun-Hsyung Chang, Somnuk Theerakulpisut (Eds.), Nova Science Publishers, New York, 2015, 527 p. ISBN: 978-1-63463-749-7; Proceedings of the 2015 International Conference on Physics and Mechanics of New Materials and Their Applications, devoted to 100-th Anniversary of the Southern Federal University, Ivan A. Parinov, Shun-Hsyung Chang, Vitaly Yu. Topolov (Eds.). Nova Science Publishers, New York, 2016, 582 p. ISBN: 978-1-63484-577-9, Proceedings of the 2016 International Conference on Physics and Mechanics of New Materials and Their Applications, Ivan A. Parinov, Shun-Hsyung Chang, Muaffaq A. Jani (Eds.). Nova Science Publishers, New York. 2017, 794 p. ISBN: 978-1-53611-033-3 and Proceedings of the 2017 International Conference on Physics and Mechanics of New Materials and Their Applications, Ivan A. Parinov, Shun-Hsyung Chang, Vijay K. Gupta (Eds.). Nova Science Publishers, New York. 2018, 619 p., ISBN: 978-1-53614-083-5, respectively.

The presented reports are divided into five scientific directions: (i) processing techniques, (ii) physics, (iii) mechanics, (iv) applications, and (v) industry and management.

These PHENMA 2018 Proceedings discuss numerous and promising problems, arising in studying advanced materials, composites with specific properties and also devices, manufactured on their base. The proposed theoretical and experimental approaches cover new processing methods of nanomaterials, piezoelectrics (including environmentally-friendly) and other advanced materials and composites. In particular, this book presents numerous results of theoretical and experimental investigations of advanced materials and devices with before-given and improved structure-sensitive properties, developed on the base of methods of inorganic and organic chemistry, modern medicine, electric elasticity and physics of condensed matter. The obtained results also include computational algorithms and original software, used in realization of numerical methods (in particular, finite-element modeling), showing new fascinating results for wide spectrum of advanced materials (which, in particular, could be obtained due to reprocessing natural materials, wasters, fruits and plants) and devices. The scientific developments, new goods and obtained results, presented in the book, demonstrate higher and improved comparative characteristics. They give a new knowledge, which is necessary for numerous applications and industrial developments. The original theoretical, numerical and experimental methods, fabricated devices and set-ups show significant possibilities in expanding the research spectrum of various physical processes and phenomena. They provide different improvements in investigation of various structure-sensitive characteristics of solids and media.

The results of the book are related to the mathematical modeling and experimental studies of advanced devices, in particular: energy-harvesters, piezogenerators, piezoelectric transducers and sensors, medical technologies etc., based on developed nano-structures, ferro-piezoelectrics and other materials with specific characteristics. The book studies very interesting modern nano- and microstructure techniques for manufacture of modern materials (for example, ZnO nanostructures), which present great interest for educational process and industrial purposes, unification and modernization of various expertise, design and analysis. Many achievements discussed in the book are linked with advanced devices, demonstrating high exactness, longevity, durability and extended opportunities to work under critical conditions. The improved properties, shown by developed materials and structures, open new possibilities to investigate numerous physical-mechanical processes and phenomena.

The book will be useful to students, post-graduate students, scientists and engineers, investigating and developing a new generation of nano-materials and nano-structures, piezo-ferroelectrics, other advanced materials with special properties, and also different devices, manufactured on their base and used in various areas of science, technique and technology. The book presents new research methods and scientific results in the Condensed Matter Physics, Materials Science, Physical and Mechanical Experiment, Processing Techniques and Engineering of Nanomaterials, Piezoelectrics, and other Advanced Materials and Composites, Numerical Methods, and also different applications and developed devices.

Ivan A. Parinov (Ed.)
Shun-Hsyung Chang (Ed.)
Yun Hae Kim (Ed.)

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Chapter 42

UTILIZATION OF GLASS WASTE AS A RAW MATERIAL MAKING OF ELECTRICAL COMPONENTS AND ENGINEERING CONSTRUCTION

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ABSTRACT

Glass is an inorganic material that cannot decompose, so in sufficient quantities, its existence as a waste will affect the environmental conditions. To reduce this impact, glass waste can be transformed to electrical components, such as fuse housing, bushing, insulator, and bus bar support. In this study, glass waste is made into a glass powder and then mixed with epoxy resin with a ratio of 3:1, then printed according to the desired shape with the cold printing method. Once tested electrically and mechanically, the molding characteristics have a penetrating voltage of 17kV/mm and mechanical strength of 5kgf/mm^2.

With reference to these characteristics, the objects or components can be made, related to electrical and construction, engineering components and used in mechanical and civil constructions.

Keywords: glass waste, epoxy resin, electrical and mechanical characteristics

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1. Introduction

Glass is a material naturally destroyed similar to an organic material, unless there is an obstacle in its processing. This processing is made only by recycling the glass into original materials or goods, namely glass, glass bottle, or glass sheet. In this processing, the necessary facilities and infrastructures are complex and costly because they must provide process equipment equivalent to the development of the glass industry [1].

Starting from the idea that there are some products, which from the viewpoint of raw materials can be replaced by glass, the use of glass waste as raw materials of new products can be realized. Some hypothetical analysis of some components of engineering construction can be made for glass (waste) material.

By processing of the systems, based on glass waste, raw materials can be used for the manufacture of the corresponding components of electrical constructions such as insulators, bushing, bus bar support, and fuse housing, as well as some other construction components as mechanical as building.

Due to the goods that will be obtained, that have high economic value and environmental cleanliness there is a decrease in the negative impact of glass waste. On the significant utilization of glass wastes, it has not been announced yet, so that they generally have a negative impact on the environment. The places of glass waste producers include hospitals, hotels, households, industrial and tourist areas [4].

2. Problem Formulation

2.1. Glass

Glass is a construction material manufactured from inorganic materials such as quartz sand. The nature of the glass is hygroscopic, transparent and has a melting point of 1200°C. Glass has a penetrating voltage of 100kV/mm rendering the same strong effect as a mechanical stress of 5kgf/mm^2. Due to this nature, glass wastes can be utilized for various construction purposes [3].

2.2. Processing

Glass waste processing can be performed by two methods of hot and cold influences. In this research, the processing is performed by using the cold method [2, 5].

Diagrammatically, the process of making electrical components and construction from glass-based materials is shown in Figure 1.

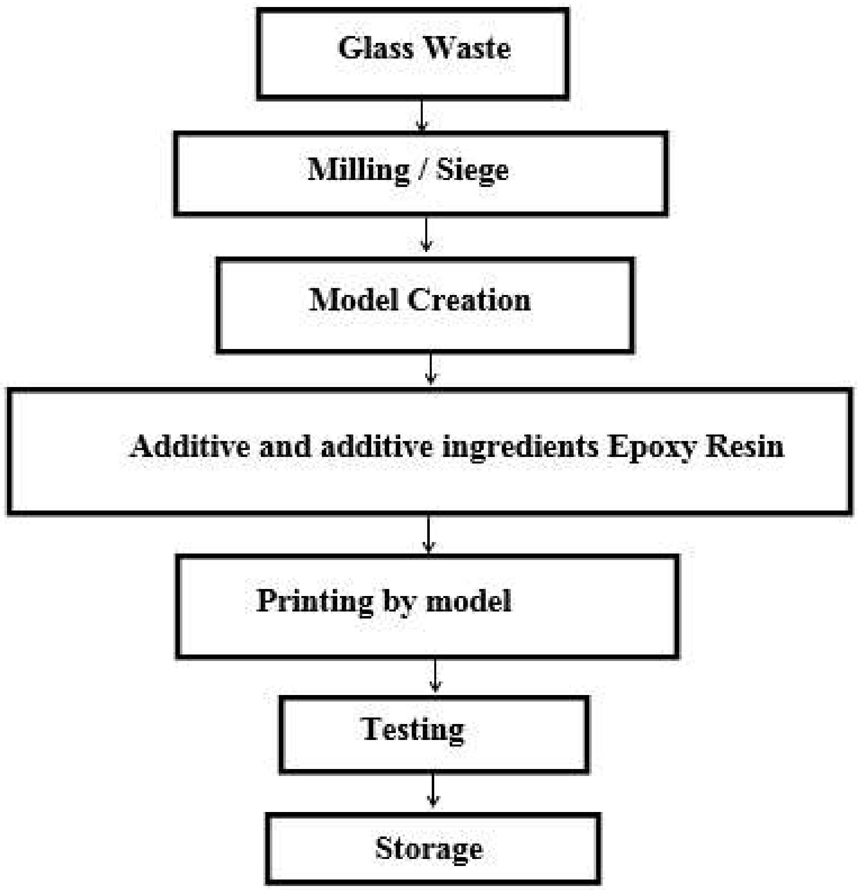

Figure 1. Flowchart of research method.

2.3. Equipment

Equipment used in this research include: (i) disc mill; (ii) cutoon screen; (iii) silicon rubber; (iv) Teflon; (v) wax.

3. Volume Fraction Optimization

3.1. Strong Insulation Testing

Testing the insulation value is defined by the circuit, presented in Figure 2.

The breakdown test results are present in Table 1. The test results, by using the circuit for measurement of insulation value (see, Figure 2), show the equivalent value of insulation resistance equal to 17kV/mm.

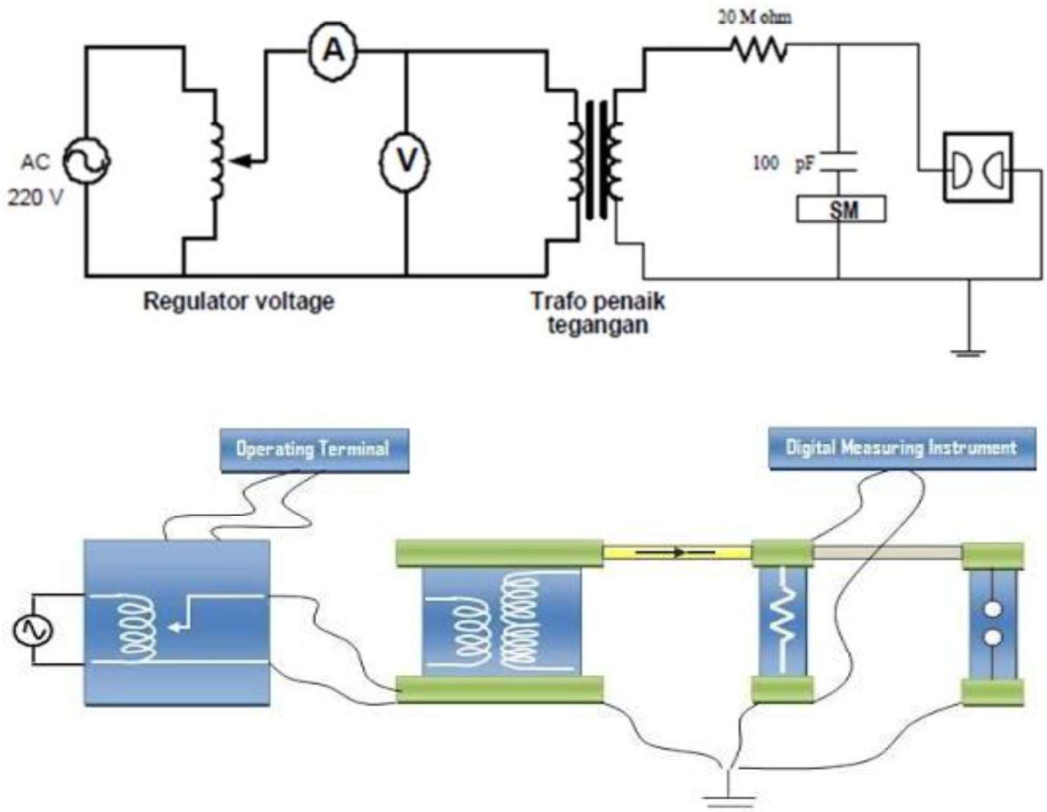

Figure 2. Circuit for measurement of insulation value.

Table 1. Breakdown test results

Test Number	Translucent Voltage (kV)	Average Translucent Voltage (kV)	Leakage Current (μA)	Dielectric Strength (kV/mm)
1	28		2	
2	49	35.8	2	17.9
3	34		2	

3.2. Mechanical Strong Testing

The mechanical test is performed by using a specimen for tensile test (see Figure 32 with a thickness of 1/8 "material).

The results of strain testing are present in Table 2 and allow us to obtain the equivalent tensile stress of 5kgf/mm^2.

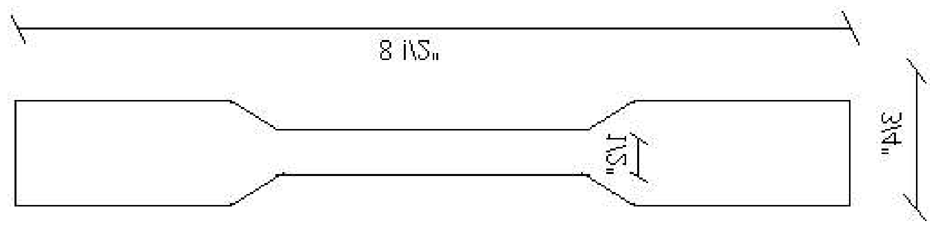

Figure 3. Sizes of sample for tensile test.

Table 2. Results of strain testing

Test Number	Maximum Tensile Stress (MPa)	Strain (%)
1	16.79	6.35
2	9.86	5.13
3	8.80	4.14

The above strain tests allow us to obtain equivalent tensile stress, therefore showing that the composition of the glass waste powder mixed with the resin provides sufficient insulation strength because it has a leakage current value of 2μA at a voltage of 48kV. So, the usefulness of this material as a medium voltage isolator is technically expedient. Moreover, in the terms of mechanical strength, the use of this material for bushing, isolator and bus bar support is also adequate.

One of the drawbacks of this material is that the influence of a direct fire during a few minutes can damage the shape of the construction. Being of use in the open air, this material is hygroscopic and does not lead to the growth of moss that is conductive.

CONCLUSION

From this research, it can be concluded that the glass waste transformed to powder and then mixed with epoxy resin can be used as an electrical insulator with a dielectric value of 17kV/mm and has a tensile strength of 5kgf/mm^2.

By using the mixtures of both materials by substituting wood, their application for manufacturing roofs or similar construction is appropriate because, due to these materials, we obtain termite-free construction, which is also escaped of other environmental and weather influences.

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