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Throughout science, digitization is occurring in shorter waves than ever before. Digital transformation can reduce operational costs and inefficiencies, and puts the technology of scientific studies/research at the center of scientific strategy. Highly complex interactions between many technologies, activities, and people make up modern scientific work.

This book reflects a science-based vision of using composite materials and high-tech devices in Engineering, Biomechanics, and Medicine/Health Care.

Scholars, professionals and experts whose work is related to the digital transformation of modern socio-economic and engineering systems in the digital age are the target audience of this book.

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PREFACE

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This book reflects a science-based vision of using composite materials and high-tech devices in Engineering, Biomechanics, and Medicine.

The results of these studies would lead to the implementation of a common integrated digital technology that could hold information about research results and their engineering, biomechanical, and medical relations, strengthen data exchange and connections among people, devices and applications in an expanded scenario that includes composite materials, high-tech equipment and big data.

Scholars, professionals and experts whose work is related to the digital transformation of modern socio-economic and engineering systems in the digital age are the target audience of this book.

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CONTENT

X-Ray Structural Analysis of the Irradiated Basalt Composite Microstructure

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Abstract. A study of the microstructure and elemental composition of the components of a composite material based on basalt after its gamma irradiation for the purpose of mechanical hardening was carried out. For this, a scanning electron microscope and a built-in energy-dispersive system were used. Local changes in morphology (nucleation of bubbles and cracks), as well as the elemental composition of the epoxy binder and filler (basalt fibers) were analyzed. Irradiation was carried out in the dose range: 5-15 Mrad. It has been shown that at irradiation doses up to 10 Mrad, new intermolecular bonds are formed and the material is strengthened. At high doses of irradiation, bond destruction and the formation of a gas phase are observed, which leads to weakening of the composite.

Keywords: Basalt composites, microstructure modification, gamma irradiation, SEM, local elemental composition.

Acknowledgments

This study was carried out with the financial support of the Ministry of Science and Higher Education of the Russian Federation within the framework of the Perm Scientific and Educational Center "Rational Subsoil Use" activity program and the project of the International Research Group (C-26/591).

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CONTROL OF POLYETHYLENE'S RADIATION CROSS-LINKING BY GAMMA IRRADIATION IN ACETYLENE ATMOSPHERE

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Abstract. To produce cross-linked polyethylene using the radiation method, a lengthy procedure for irradiating the polyethylene is required. Reducing the time spent on irradiation will increase the yield of finished products per unit time and increase production efficiency. It has been experimentally confirmed that irradiation of polyethylene in the presence of hydrocarbon gases (for example, in the presence of acetylene) makes it possible to achieve the required degree of intermolecular cross-linking in less time. The article presents a modified algorithm for the production of cross-linked polyethylene, and identifies parameters whose changes can influence the speed of the production process. The problem of managing the production process is formulated in order to minimize the time spent on the production of cross-linked polyethylene. A description of mathematical models is given that make it possible to develop a control system for the production process of polyethylene modification using radiation exposure.

Keywords: cross-linked polyethylene, radiation technology, gas diffusion, production management.

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The Use High-Porosity Cellular Carbon to Replace Bone Defects from Children

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Abstract. The results of surgical treatment of 8-16-year-old children with extensive bone defects after pathological tissue resection with the use of high-porosity cellular carbon in isolation (9 patients) and in combination with autografts (3 patients) are presented. Children with lesions of long bone segments – the tibia, humerus, and femur (10 patients) predominated. The Musculo Skeletal Tumor Society Score was used as the basis for outcome assessment, and clinical and radiological data were assessed. The results in 100% of treated patients were rated as good in terms of 7 to 12 years after surgery. There were no complications in the operated patients. The efficacy of treatment according to the ISOLS system was + 56.8% after treatment in the group after carbon plastic surgery, the postoperative score became higher by more than 1.5 times, there were no recurrences of the defects, full integration of the implanted materials with good clinical and radiological results were registered. High-porous cellular carbon is suitable for effective plasty of bone defects in children and when properly applied leads to good results and no complications.

Keywords: bone replacement materials, high-porous cellular carbon, tumor and tumor-like diseases.

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High-Tech Equipment for Health Research

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Abstract. High-tech medical equipment for telemedicine, nuclear medicine, etc. is needed for patients' treatment in modern medical institutions. In order to provide medical institutions with such equipment, it is necessary to determine the adequacy of the medical equipment already available in hospitals and/or the need for the purchase of more modern and efficient medical equipment. We should also remember that the medical institutions are responsible for providing medical services that meet the standards of economy and efficiency, free of fraud, misuse, and so on. The concept of value-based healthcare institutions demonstrates improved quality of care through rigorous quality assurance measures. But in some cases, the management of these institutions falls short of their remarkable potential because of the lack of information, the lack of incentives, and the fragmented nature of the organization between management and practitioners. This chapter provides scientific view for determining appropriateness and necessity of high-tech medical equipment by integrating service data, and a logical scheme for evaluating High-tech medical equipment alternatives.

Keywords: High-tech medical equipment, cost reduction, health research.

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