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Dyscyplina: Inżynieria Materiałowa

[redacted]

Summary

The work attempted to produce innovative material compositions based on mineral raw materials (available in Poland) and CRT glass cullet. The traditional method of melting raw material sets and vitrifying them with the addition of cathode ray tube glass was used to produce the materials. The use of waste CRT (cathode-ray tube) cullet in the production of glasses and glass-crystalline materials is a new material which, according to the author of this dissertation, should contribute to reducing the production costs of these materials, reducing the demand for non-renewable raw materials in the technological process and reducing the amount of electronic waste deposited in landfills. New material compositions were developed with the possibility of their practical use in the ceramics and glass industries in mind.

The subject of the doctoral thesis combines the aspects of materials science and technology with environmental protection issues. The pro-ecological nature of the doctoral thesis results from an attempt to effectively manage waste, i.e. glass from CRT picture tubes. This waste is an increasing environmental problem due to the mass replacement of classic CRT TVs and monitors with more modern equipment based on LCD technology.

As part of the doctoral thesis, a materials science analysis of selected mineral raw materials, i.e. basalt, diabase, melaphyre and amphibolite, was carried out, combined with an assessment of the possibilities of their practical use. Moreover, the influence of melting process parameters on the structure of the obtained amorphous materials was analyzed, their basic properties were determined and the directed crystallization process was carried out. The result of the analysis was the development of guidelines and research procedures enabling the preparation of glasses and the devitrification of the produced amorphous materials.

In order to assess the correctness of the adopted assumptions, research was carried out, among others: in the field of thermal analysis (DSC/TG, dilatometric tests) and high-temperature microscopy. The scope of research also included X-ray phase analysis, microstructural studies in the field of light microscopy and scanning electron microscopy, and Fourier infrared spectroscopy. Moreover, the chemical composition of raw materials and manufactured glasses was determined using X-ray fluorescence spectroscopy (XRF) and EDS

analysis (EDS). Complementing the above-mentioned The research included the analysis of physicochemical and mechanical properties, i.e. viscosity, acidity modulus and hardness.

Based on the research conducted and the results obtained, the possibility of using selected mineral raw materials and CRT glass cullet in the production of glasses and glass-crystalline materials was assessed. The main practical goal of the research was to develop material guidelines and technological procedures that would enable the replacement of traditional mineral raw materials and, at the same time, the use of glass from CRT picture tubes, which is waste with a negative impact on the environment. The research carried out allowed for achieving the intended research goals. The designed and melted glass sets with a varying share of mineral raw material and CRT glass cullet were characterized by properties that indicate the possibility of their practical use. Depending on the volume fraction of individual components of the developed compositions, as well as the melting and crystallization process, amorphous and glass-crystalline materials were obtained, the properties of which changed depending on the process conditions. The conceptual and experimental work carried out allowed for the development and production of materials which, due to their structure, microstructure and properties, can, according to the author of this dissertation, be used in many industries, contributing at the same time to the reduction of environmentally harmful waste stored in landfills.

The first part of the work includes literature studies and the analysis and discussion of the main thematic threads of the work. This part also highlights the research problem that inspired the author of the work to undertake research and implement it. The theoretical part of the work includes, among others, the characteristics of glasses and the amorphous state, as well as traditional and unconventional glass raw materials, as well as secondary raw materials - including CRT glass cullet. Moreover, the crystallization process of glasses and the crystallization conditions enabling the preparation of glass-crystalline materials were discussed. One of the aspects that was highlighted in the literature was the possibility of using basalt, melaphyre, amphibolite, diabase and CRT glass cullet in the production of glassy materials. An analysis was also made of glass-crystalline materials, which are very popular materials due to their properties and application potential. The literary part was finished with a chapter summarizing the topicality of the chosen topic, justifying its selection and presenting the utilitarian significance of the research issues.

The practical part of the work includes research on selected mineral raw materials (i.e. basalt, diabase, melaphyre and amphibolite), CRT glass cullet and glasses made from

base materials, as well as glasses and glass-crystalline materials modified with CRT glass cullet. The practical part of the work ends with a summary of the research results and statements and conclusions resulting from the research conducted.