Workshop « Soft Material Models »

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DEVELOPMENT OF PHOSPHATE GLASS FIBERS AND STUDY OF THEIR CHEMICAL AND MECHANICAL PROPERTIES

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Abstract

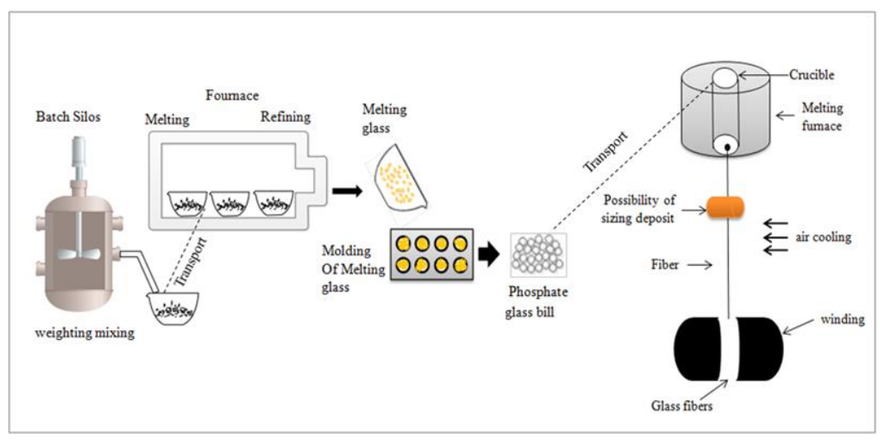
This research focuses on the use of phosphate glass spinning technology to produce fibers suitable for various applications[1]. Phosphate glasses have interesting physical properties such as controllable chemical durability in water, low processing temperatures and high coefficient of thermal expansion[2]. However, these properties and applications vary from region to region. The objective of this study is to evaluate the structural and surface properties of the fibers obtained by X-ray diffraction (XRD), scanning electron microscopy (SEM) and tensile strength analysis.

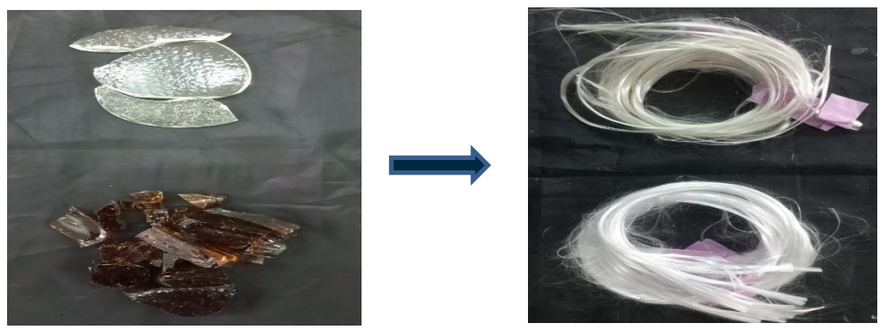
Methodology

Elaboration of Phosphate Glass Fibers

To produce phosphate glasses with varying compositions, powders of P2O5, CaO, Fe2O3, and other metal oxides were mixed and placed in crucibles. The crucibles were then heated in an electric furnace at 1000°C for 3 hours. After processing, the resulting phosphate glasses were transformed into fibers using a monofilament extruder at a temperature between 600°C and 700°C and a spinning speed of 500m/min.

X-ray diffraction analysis of PG: X-ray diffraction (XRD) scanning was used to confirm the amorphous nature of the phosphate glasses.





Characterization

Scanning electron microscopy (SEM) analysis : SEM analysis was used to evaluate the surface morphology of phosphate glass fibers

Mechanical properties of PGF: The mechanical properties of phosphate glass fibers were obtained by single filament testing using LUDWIC Mpk traction resistance machine, following the international standard NF EN ISO 11566.

Context

Morocco, which has about 75% of the world's phosphate reserves, is one of the world's leading phosphate exporters. Our work aims to explore the multiple applications of Moroccan phosphate, focusing on the automotive, construction and biomedical industries, in order to valorize this abundant resource and contribute to the economic and sustainable development of Morocco.

Results

Characterization

▪ **X-ray diffraction analysis of PG:**

X-ray diffraction (XRD) scanning shown in Figure.1,was confirm the amorphous nature of the elaborate phosphate glasses.

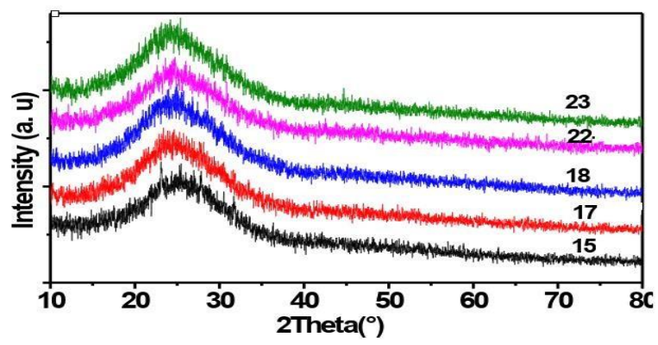


Figure.1: X-ray diffraction analysis of Phosphate glasses

▪ **Scanning electron microscopy (SEM) analysis:**

SEM analysis has been confirmed the homogeneity surface of phosphate glass fibers.

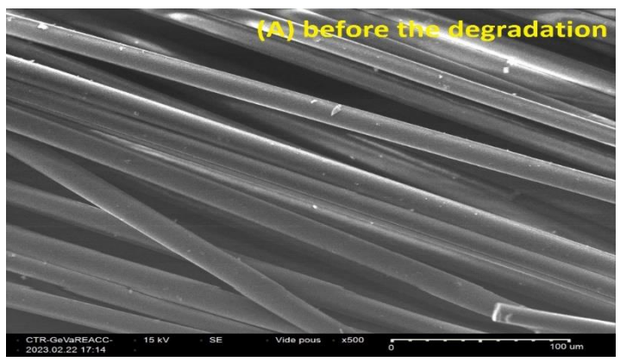


Figure 2: Scanning electron microscopy analysis of phosphate glass fibers

▪ **Mechanical properties of PGF:**

The tensile strength of phosphate glass fibers varied between (2200-2600 MPa)

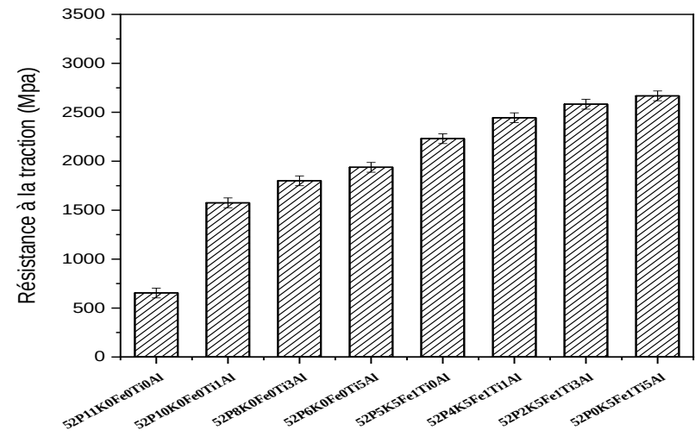


Figure 3: Tensile strength of phosphate glass fibers

Conclusion and perspectives

The properties of the developed phosphate glass fibers were studied using various techniques: X-ray diffraction (XRD), scanning electron microscopy (SEM) and tensile strength. The results obtained show that phosphate glass fibers have good mechanical properties, good flexibility and good homogeneity. Phosphate glass fibers based on phosphate open many fields of applications among which: composites, agro-textiles, geotextiles, ... etc.

References

[1] N. Saloumi, M. El Bouchti, Y. Tamraoui, B. Manoun, H. Hannache, et O. Cherkaoui, « Structural, chemical and mechanical properties of phosphate glass fibers », *Journal of Non-Crystalline Solids*, vol. 522, p. 119587, oct. 2019, doi: 10.1016/j.jnoncrysol.2019.119587.

[2] O. J. Eddine *et al.*, « Mechanical, structural, and chemical properties of unmodified and iron-modified phosphate glass fibers based on natural phosphate and kaolin clay », *Materials Chemistry and Physics*, vol. 255, p. 123573, nov. 2020, doi: 10.1016/j.matchemphys.2020.123573.