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Sizing effect for phosphate glass fibers

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Abstract

Phosphate-based glasses are one of the most interesting materials, because of their functional physical and chemical properties, including high thermal expansion coefficient, low melting, and processing temperatures and controllable chemical durability in an aqueous environment. According to the spinning of phosphate glass fibers, studies have revealed that the use of phosphate glass fibers is limited due to their biodegradability, which necessitates a specific sizing process. Therefore, their application as reinforcement in composite materials requires a tailored sizing treatment to enhance their durability and fiber/matrix adhesion.

Context

Composite materials are widely used in various fields, particularly those reinforced with silica glass fibers. Morocco is a country that imports silica glass fiber, but it has significant resources in terms of phosphates, which can be utilized to produce phosphate glass fibers. Currently, ESITH has successfully produced phosphate glass fibers from phosphate rock.

Figure 1:application field of phosphate glass fibers

Methodology

The process of manufacturing fiber glass involves several stages: preparation of the batch (a mixture of various raw materials); melting the batch to obtain molten glass; fiberizing the glass; sizing the glass; winding the fiber on to a spool and finishing. The most significant advantage of sizing is to ensure compatibility between the glass and the matrix to achieve better mechanical, chemical, and thermal characteristics, particularly over the long-term (water resistance, fatigue, tension cracking, etc.) end mixture.

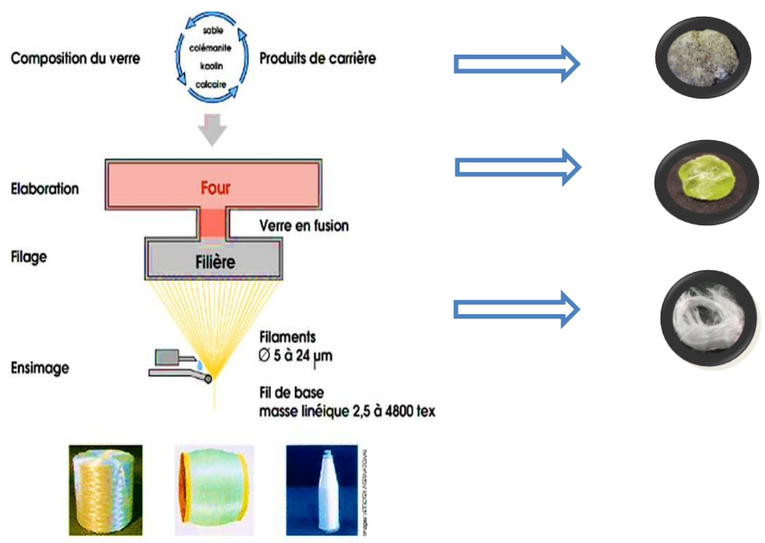

Figure 2: Elaboration process of phosphate glass fibres

Results

The durability testing of a developed phosphate glass fiber formulation revealed complete fiber degradation after one week, regardless of the pH, under aggressive conditions. Therefore, protecting the fiber is necessary if it is to be used in composite materials. The sizing formulation contains the most cases a coupling agent, a film-forming agent, a lubricant, and antistatic agents. Each sizing agent brings specific characteristics to the dimension, and their combination forms an extremely complex mixture.

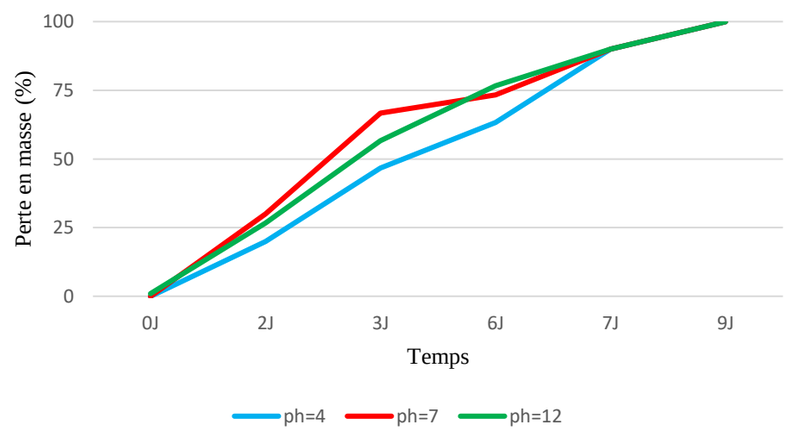

Figure 3: Percentage loss in mass of phosphate glass fibers as a function of time at ph= 4, 7 and 12

Conclusion and perspectives

In summary, our literature review has allowed us to select a set of compounds that we will evaluate in sizing formulations for phosphate glass fibers. In the upcoming experiments, we will investigate the coupling agents such as tetraethyl orthosilicate, aminopropyltriethoxysilane, and other types of agents to ensure protection against abrasion during the yarn passage through the loom dies, increase filament stiffness, improve the fiber/matrix interface, facilitate resin impregnation during processing, and eliminate electrostatic charges.

References

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