INTERNATIONAL WORKSHOP ADITIVE MANUFACTURING

1ST INTERNATIONAL CONGRESS ON ADDITIVE MANUFACTURING

BOOK OF ABSTRACTS

IWAM 22

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BOOK OF ABSTRACTS

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WELCOME

Additive manufacturing technologies are playing a decisive role in the laboratory environment, making a significant difference in STEAM education. Students use additive manufacturing to create physical models, topographic maps, biology artifacts, artwork, all types of engineering prototypes and solving mathematics challenges. By bringing additive manufacturing capabilities to the classroom, educators can raise interest in STEAM, introduce new concepts and capabilities, and help set the future for more skilled STEAM professionals.

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Tensile and flexural strength of flax fiber reinforced composites with and without chemical treatment

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ABSTRACT

PLA composites were reinforced with a natural fiber, flax fiber. A Taguchi L18 matrix was created and for each test 6 specimens were run, varying the temperature, fiber percentage, fill percentage of the specimens, and whether or not the flax fiber was treated. As for the treatment of flax, when applicable, it was treated with sodium hydroxide (NaOH). The temperatures used are 190°C, 200°C and 220°C. The percentage of fiber varies in 10, 15 and 20 fiber strands. The filling percentage of the specimen varies between 25%, 50% and 100%. This was followed by a study of the tensile and flexural strength of the reinforced composites. The optimal combinations for increased tensile and flexural strength were obtained with the following parameters for tensile: with/without chemical treatment, with a temperature of 200°C, 10 fibers and a filler percentage of 100%. For bending the parameters are: with chemical treatment, a temperature of 190°C, 10 fibers and a fill percentage of 100%. With the confirmation tests a value for the maximum tensile stress of 19.38 MPa and for bending of 73.20 MPa was obtained.

INTRODUCTION

Polymeric materials that derive from petroleum in their composition have volatile organic compounds that can cause damage to the environment and human health. With the increasing demand for sustainability and due to the energy crisis that has been experienced, it is necessary to find alternatives. Many automotive components use synthetic fibers for strength, so it is necessary to conduct a study in order to circumvent the causes of these products and find a sustainable way to replace them. Natural fibers, are fibers that are not synthetic or manufactured. These fibers come only from animals or plants. Natural fibers have unique characteristics such as abundance, non-toxicity, high performance, versatility, and easy processing at low cost. The natural fiber reinforced polymer composites (NFPCs), have several applications, besides the automotive industry, also in the construction industry due to their strength, low density, biodegradability and high lifetime. The fibers most used in industrial applications are flax, knaf and hemp because of the fiber's strength properties. Flax fiber is considered one of the strongest fibers, because it has a very complex structure. However, since natural fibers have some limitations, the formation of the composite and the treatment parameters must be controlled in order for the product to improve its properties. Due to these limitations it is necessary to proceed to the use of treatment processes that can be chemical or physical. One of the most commonly used chemical treatments is the alkaline one, in which the cracks are submerged in an alkaline solution, namely NaOH (sodium hydroxide), for a relative period of time. This increases the fiber's surface roughness and improves its mechanical properties. For the substitution of products that do not come from renewable sources, it is possible to use biodegradable polymers, i.e. products from renewable sources, such as composites with natural fibers. PLA (polylactic acid) is a biodegradable polymer, with much technological interest due to its applications in the environmental field. It is a type of impact-modified filament for the 3D printer, which is sustainable. Natural fibers can be added to PLA to reduce environmental and production costs.

This study aims to compare the tensile and flexural strength of flax fiber reinforced composites by analysing the influence that the amount of flax fiber, the temperature, the percentage of filler and the presence or absence of NaOH treatment have on the mechanical strength of the composites.

RESULTS

Figure 1 shows the mean values of the maximum stresses for the 6 specimens in each test. It can be seen that test 6 obtained the highest maximum tensile stress value for the tensile test with a value of 19.98MPa. For the bending tests, the one with the highest stress was test 8 with a value of 72.94MPa.

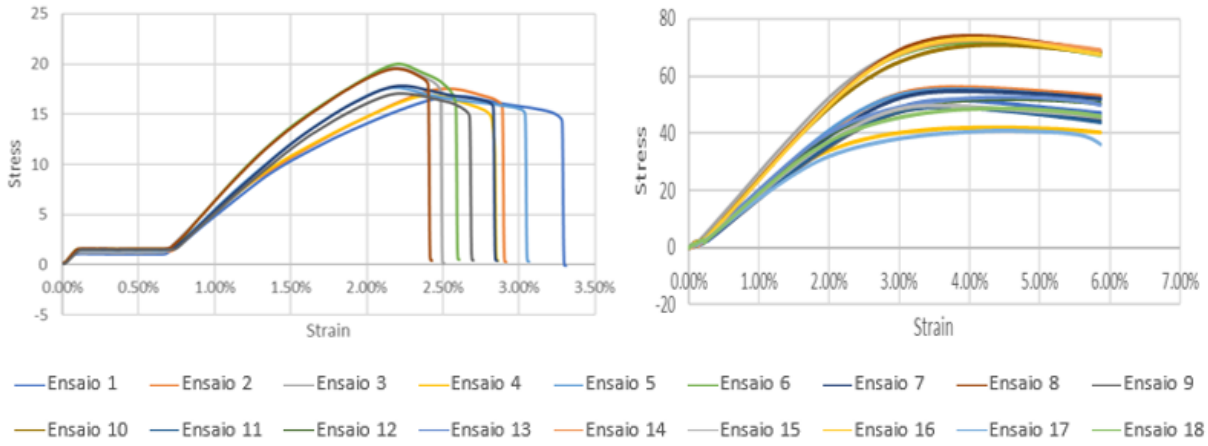

Figure 1- Stress-strain for tensile and flexural strength, respectively.

With the use of analysis of variance, it is possible to verify that for tensile and flexural strength, the most significant control factors are temperature and the filling percentage of the specimen, with the remaining factors varying. That is, for tensile strength, the percentage of filler was very significant with 96.69%, followed by temperature, fiber percentage, and the use or not of fiber treat-ment, with 1.12%, 0.22%, and 0%, respectively. For flexural strength, the percentage of fill-er was also the most significant with 95.42%, followed by temperature, the use or not of fiber treatment, and the percentage of fibers with 0.85%, 0.29% and 0.17%, respectively.

CONCLUSIONS

After analyzing the results of this study, it is possible to conclude that the maximum stress for the tensile test is 19.98 MPa and for the bending is 72.94 MPa with a standard deviation of 0.36 and 2.09 respectively. It can be admitted right away that flax fiber rein-forced composites have higher flexural strength than tensile strength.

With the analysis of variance, it was found that the percentage of filler was the parameter with the greatest contribution to the increase in tensile and flexural strength with percentages of 96.69% and 95.42%, respectively.

REFERENCES

Paulo A., Ribeiro J. and Rocha J. - Tensile and flexural strength of flax fiber reinforced composites with and without chemical treatment – Journal of Composites Science, 2022.