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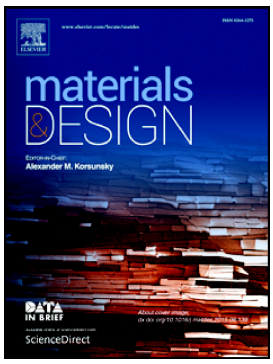

Random short sisal fiber biocomposites: Optimal manufacturing process and reliable theoretical models

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Random short sisal fiber biocomposites: optimal manufacturing process and reliable theoretical models

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Abstract
Although several works have been published in literature on agave fibers and their biocomposites, accurate information about the choice of both the fibers and the manufacturing processes that allow the user to optimize the biocomposites properties in terms of strength and stiffness are not yet available; also, no theoretical models that can be used for an accurate evaluation of the mechanical properties of these biocomposites, are reported.
To this aim, the present work intends to give a contribution by considering green epoxy biocomposites reinforced by both short and discontinuous sisal agave fibers arranged in proper MAT-type fabrics. In particular, an optimized manufacturing process that allows to obtain good quality biocomposites, is proposed. A detailed analysis of the experimental results, obtained through preliminary pull-out and tensile tests carried out, along with an accurate analysis of the damage process performed by SEM micrographs, have allowed to develop reliable theoretical models that permit the mechanical properties evaluation of the analyzed biocomposites.
Finally, the comparison with the most performing short/discontinuous fiber biocomposites reported in literature has shown how the implemented biocomposites exhibit comparable tensile strength and significantly higher stiffness, also respect to biocomposites reinforced by more stiff and more expensive fibers (flax, hemp, etc.).

Keywords: biocomposites, natural fibers, sisal fibers, eco-friendly matrix.

1. INTRODUCTION

Biocomposites are composite materials consisting of an ecofriendly or renewable polymeric matrix, reinforced by natural fibers such as flax, hemp, agave, etc. They are already quite used in different sectors of industrial production (shipbuilding, sports articles, packaging) and, above all, in automotive and civil sectors for non-structural applications (filling material, soundproofing, lightening, etc.), where lightness and low cost, both lower than those of any composite reinforced by synthetic fibers, as well as good thermal and acoustic insulation capacity, are particularly appreciated. In general, they are randomly oriented short-fiber composite materials, obtained by molding or extrusion processes. Unlike synthetic composites and advanced materials recently obtained by plant biomass [1-4], both the low specific weight and the low cost of biocomposites are essentially related to the low weight and low cost of most natural fibers, combined with the low cost of the automated manufacturing processes used for mass production. In literature, biocomposites with both partially ecofriendly thermosetting matrices and with partially or totally renewable thermoplastic matrices, have been developed. To this aim, particular attention has been paid to the fibers already used in the textile industry such as flax, hemp, jute [5-10], as well as to the other fibers used only for the craft production, as agave, kenaf, ramie, coir and curaua [11-20].
Among natural fibers, the agave fibers, widely and promptly available in the current market for potential industrial exploitation, have interesting properties for the manufacture of biocomposites, such as good fiber-matrix adhesion, low damageability, low specific weight, low skin irritability during the manufacture process and, above all, high toughness and good mechanical characteristics (strength and stiffness), which can also be further improved by appropriate optimization techniques (proper fiber selection and suitable extraction process) [21, 22].

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