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Fibers Waste in Textiles, Their Recycling and Applications in Composites

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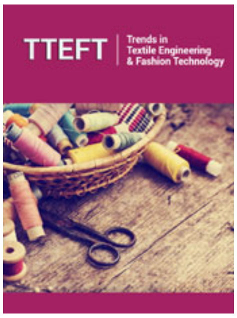
ISSN: 2578-0271



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Submission: April 27, 2020
Published: May 22, 2020

Volume 6 - Issue 1

How to cite this article: Patti A, Acierno D. Fibers Waste in Textiles, Their Recycling and Applications in Composites. Trends Textile Eng Fashion Technol. 6(1). TTEFT. 000628. 2020. DOI: 10.31031/TTEFT.2020.06.000628

Abstract

This work aims to briefly overview the issue of the large consumption of textiles in the world, linked to the complexity of their production from the environmental impact point of view, by highlighting the need of recycling and reuses operations, and the possible applications of the recovered-fibers in the world of eco-friendly composites.

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Since prehistoric era, leather and natural fibers have been used by humans to obtain useful clothing to cover and protect them. In the Neolithic, the first evidence of true textures with basket-weave on clay has been found in Iraq, and the plain-weave on a bone in southern Turkey [1]. By the third millennium BC, the usage of fibers has been considerably widespread, and weaving of cotton has already been well-situated in Pakistan and in India. In the beginning of the 18th century, with the industrial revolution and the development of machines, the fiber manufacturing process has been launched [2]. During the second half of century E. Cartwright developed the first power loom, and E. Whitney invented the cotton gin: the consumption of the cotton increased from about 4 to 300 million pounds. A century later, by the findings of the synthesis of long polymer chains with properties similar to cellulose, silk, and rubber, the new fields of synthetic fabrics have been opened with nylon 66, nylon 6, acrylic and polyester fibers [3]. Since then, the textiles market, based on natural materials, synthetics and blends of both, has gradually grown up, not only due to the increase in the population in the world, but also to follow economic and marketing aspects linked to the world of the new trend and style, apparel and fashion [4].

Inevitably, the growing demand of the cloth products led to an increase of the environmental impact of the related industry, being this latter one among the most polluting and harmful productions. In fact, the textile manufacturing, starting from raw materials, going through the various operations (fiber production, pretreatment, dyeing, and finishing), requires a large use of hazardous chemicals, such as pesticides, solvent, mothproofing agents, heavy and toxic metals, disperse dyes, until a huge volume of water [5]. Additionally, an extensive dissipation of energy and power, air emission, fuel consumption for transportation, use of non-biodegradable packaging materials, and generation of large quantities of solid wastes should be considered in the evaluation of the alteration of the quality of the surrounding ecosystem [6]. In the land filling, the natural fibers may take weeks or years to decompose by releasing methane and carbon dioxide; on the contrary, synthetic fibers take 30-40 years to break, and require hundred years to fully decompose, evenly by delivering adverse substances into the surrounding soil [7].

In the light of these complex ecological issues, European directives have promoted and encouraged the recovery of textile waste [8]. The recycling phase of the discarded fabrics could be useful in reducing the virgin yarns production, and, in general, in decreasing the environmental impact, compared to the incineration and land filling processes. Additionally, the reuse of thrown garments or scraps of cloths could be preferred over the recycling operation, since it avoids the technological treatments at the end of the product life cycle [9].

The textile waste lifecycle model proposed by Domina & Koch [10] represents different classes of waste coming from the fabric and apparel. The first one involves the pre-consumer waste generated by retailers: these materials, primarily in the form of unsold merchandise, can be easily re-integrated through the sale in an outlet or a jobber, or through no-profit organization. The second group regards the post-consumer waste, generated by the public or by the manufactures; these products are composed of fiber, yam, fabric scraps and apparel cuttings, and may be allocated in landfills or in incinerators, or may be converted into energy or powder for the manufacturing, or may be sold to a textile waste recycler and re-converted into reusable goods (Figure 1).

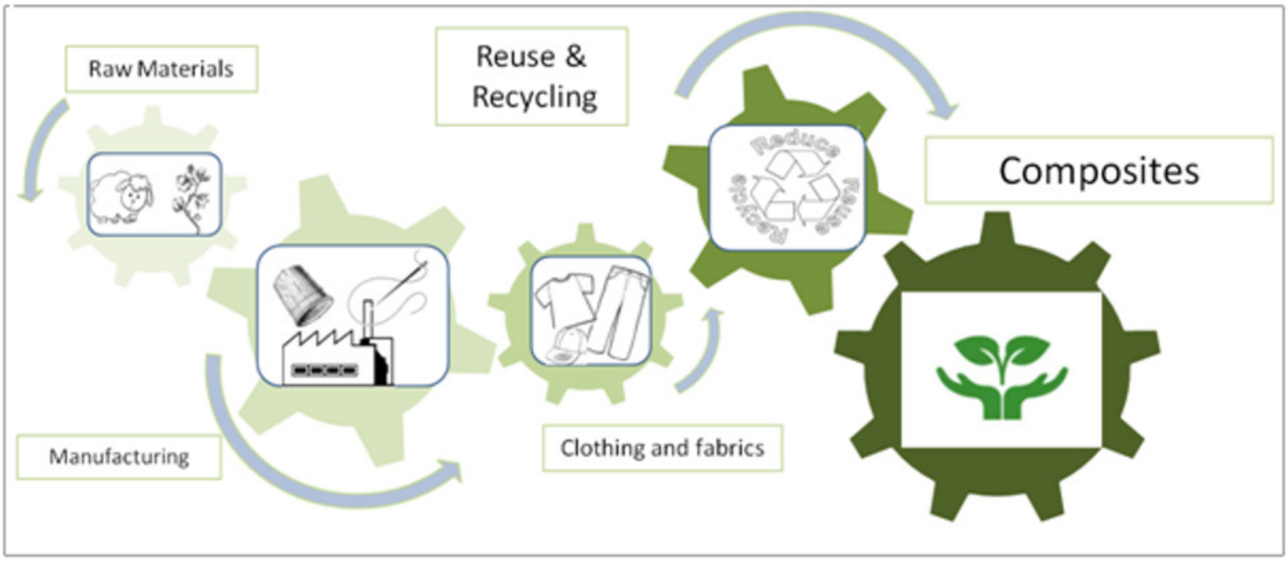

Figure 1

One of the possible alternatives for the recovery of the fibers is their applications, as fillers, for realizing fiber-reinforced composites (FRC). Experimental evidences have shown as the presence of fibers was crucial in affecting the thermal and mechanical features, and eco-compatibility of fully degradable matrices (polylactic acid, thermoplastic starch, cellulose) and partially degradable ones (polypropylene, polyester, polyethylene, polyvinyl alcohol) in the light of the ultimate purpose of composites realization [11]. In this context, cotton based-fabric, opened into a fibrous form by garneting technique, was blended with polypropylene for realizing 3D woven textiles [12], or mixed with hardwood strand core for attaining the oriented panels [13]. Denim fabric was recycled and converted into epoxy-based composites by using, as fabrication route, the needle-punching non-woven [14]. An insulation material was realized by a non-homogeneous medium obtained from discarded components of cotton (70%), wool (15%) and acrylic, and polyester fibers (15%) recovered by the disposal of plastic bottles [15]. Cloth scraps and clippings of cotton and jute materials, together with glass fabric, were incorporated into thermosetting of unsaturated polyester resin for fabricating laminate composites with the stacking of fabric plies [16].

In conclusion, given the huge amount of solid waste of the textile business, the high environmental impact of the production, and the complicated operation of the disposal, it is necessary to provide a convenient reintegration of waste products, for example, in the designing of compounds, by taking advantage from the point of view of eco-compatibility and environmental sustainability.

Acknowledgement

A.Patti wished to thank the Italian Ministry of Education, Universities and Research (MIUR) in the framework of Action 1.2 “Researcher Mobility” of The Axis I of PON R&I 2014-2020 under the call AIM-Attrazione e Mobilità Internazionale.

References

1. Barber E J W (1992) Prehistoric textiles: The development of cloth in the neolithic and bronze ages with special reference to the aegean. Princeton University Press, Princeton, New Jersey, p. 471.
2. Fisher CH (1981) History of natural fibers. Journal of Macromolecular Science: Part A-Chemistry 15(7): 1345-1375.
3. Heckert WW (1953) Synthetic fibers. Journal of Chemical Education 30(4): 166-178.
4. Pensupa N, Leu SY, Hu Y, Du C, Liu H, et al. (2017) Recent trends in sustainable textile waste recycling methods: Current situation and future prospects. In: Lin C (Ed.), Chemistry and Chemical Technologies in Waste Valorization. Topics in Current Chemistry Collections. Springer, Cham, p. 283.
5. Stone C, Windsor F M, Munday M, Durance I (2000) Natural or synthetic-how global trends in textile usage threaten freshwater environments. Science of The Total Environment 718: 134689-134699.
6. Chowdhury AK (2014) Environmental Impacts of the textile industry and its assessment through life cycle assessment. In: Muthu SS (eds),

Roadmap to Sustainable Textiles and Clothing. Springer, Singapore, p. 355.

7. Nayak R (2019) Sustainable technologies for fashion and textiles. Elsevier, United Kingdom, p. 394.
8. Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on Waste and Repealing Certain Directives (Text with EEA Relevance) EC.
9. Sandin G, Peters GM (2018) Environmental impact of textile reuse and recycling A review. Journal of Cleaner Production 184: 353-365.
10. Domina T, Koch K (1997) The Textile Waste Lifecycle. Clothing and Textiles Research Journal 15(2): 96-102.
11. Gholampour A, Ozbakkaloglu T (2000) A review of natural fiber composites: properties, modification and processing techniques, characterization, applications. Journal of Materials Science 55: 829-892.
12. Mishra R, Behera B, Militky J (2014) Recycling of textile waste into green composites: Performance characterization. Polymer Composites 35(10): 1960-1967.
13. Meng X, Fan W, Ma Y, Wei T, Dou H, et al. (2020) Recycling of denim fabric wastes into high-performance composites using the needle-punching nonwoven fabrication route. Textile Research Journal 90(5-6): 695-709.
14. Vallance D B, Gray J, Lentz H (2012) Properties of wood/recycled textile composite panels. Wood and Fiber Science 44(3): 310-318.
15. Tilioua A, Libessart L, LassueS (2018) Characterization of the thermal properties of fibrous insulation materials made from recycled textile fibers for building applications: Theoretical and experimental analyses. Applied Thermal Engineering 142: 56-67.
16. Masood Z, Ahmad S, Umair M, Shaker K, Nawab Y, et al. (2018) Mechanical Behaviour of Hybrid Composites Developed from Textile Waste. Fibers & Textiles in Eastern Europe 26(127): 46-52.