Editorial
Special Issue on Innovative Textiles in the Era of Circular Economy

Rocco Furferi

Department of Industrial Engineering, University of Florence, 50139 Firenze, Italy; rocco.furferi@unifi.it

Abstract: This work presents the Special Issue on Innovative Textiles in the Era of Circular Economy, published in the Applied Sciences Journal. Such an issue was introduced to promote papers related to the textile field aiming at the development of a range of sustainable processes, technologies, products, and actions for the improvement of human well-being and social equity. Works proposed in this Special Issue are aimed at significantly reducing environmental risks and ecological shortcomings related to the development of textile products.

Keywords: circular economy; innovative textiles

1. Introduction

In recent years, the interaction between business and sustainability, i.e., the so-called sustainable business, has become one of the most relevant challenges for innovation-driven companies, which have consistently started to manage their impact on natural ecosystems and society. Implementing sustainability principles in businesses involves costs, investments, changes, and innovation efforts that do not always result in immediate economic benefits. Contrarily, a sustainable approach is seen as a strategic opportunity for growth, allowing the introduction on the market of products with an extremely reduced impact on the environment and a recovery both in terms of energy and materials at the end of the products’ life. Moreover, also in the light of the recent focus on environmental sustainability and on the circular economy, the development of eco-sustainable systems is a trump card for attracting increasingly large portions of the market that are today aware of the ecological challenges which society is expected to face in the future.

The textile and clothing industry is no exception in this regard. In fact, textiles have a significant environmental impact, owing to both overconsumption and production processes that necessitate, among other things, finishing and dyeing. As a result, taking on the challenge of developing completely green textiles for the circular economy [1,2], as well as strict control of the entire design, production, distribution, and end-of-life analysis chain, is a strategic goal today. Therefore, the most advanced textile industries are transitioning from traditional manufacturing processes to a systemic approach that considers the circular economy, which includes the efficient use of natural resources, renewable energy use, reduced or zero waste production, and end-of-life management.

The aforementioned actions are framed within a logic of Product Lifecycle Thinking [3], which has recently been recognized as a fundamental strategy for the European Community within a broader framework of actions for the sustainable development and promotion of integrated systems of environmental policy among European States (Directorate General Environment, with support from the European Environment Agency).

In this context, this Special Issue on Innovative Textiles in the Era of Circular Economy was introduced to promote papers related to the textile field aiming at the development of a range of sustainable processes, technologies, products, and actions for the improvement of human well-being and social equity. Works proposed in this Special Issue are aimed at significantly reducing environmental risks and ecological shortcomings related to the development of textile products.
2. Innovative Textiles in the Era of Circular Economy

This Special Issue collects the latest research on relevant topics related to the development of innovative textiles in the context of the circular economy (CE). The proposed papers addressed challenging issues related to the introduction of the CE paradigm in the Textile Industry. There were 11 papers submitted to this Special Issue, and 5 papers were accepted (i.e., a 45.5% acceptance rate). Various topics are addressed in this Special Issue: bio-based materials and fibers, life cycle assessment, resin composites, innovative textiles with enhanced mechanical properties, and thermal insulation.

The first paper, “Design and Manufacturing of an Innovative Triple-Layer Thermo-Insulated Fabric”, authored by Furferei, R., Mantellassi, F., and Volpe, Y., provides new insights on the development of a fabric in which a certain degree of thermal insulation is performed directly thanks to the structure of its weave. In detail, the authors propose a fabric where the thermoregulation function is entrusted to one of the yarns (suitably volumized to reduce its density and trap the air) and suggest that this architecture could be an important improvement compared to contemporary fabrics. The new developed kind of triple-layer thermo-insulated innovative fabric (named by the authors as T4Innovation) is able to ensure thermal insulation in a reduced thickness and is manufactured in a single weaving phase, greatly facilitating the subsequent operations of the garment maker [4].

The second paper, “Thermal and Mechanical Characteristics of Okra Fibers Obtained via Water- and Dew-Retting”, authored by Stawski, D., Caliskan, E., Yilmaz, N.D., and Krucinska, I., investigates and compares the properties of okra (abelmoschus esculentus, a plant grown in tropical and subtropical regions) fibers obtained from various parts of the plant via dew-retting and water-retting [5]. This proposed work fills a gap in the scientific literature where only a few studies have dealt with okra fibers, and none are available on dew-retting okra bast fibers. Special emphasis is given to the thermal performance of fibers as they are processed under various conditions, and as part of composite systems operating at elevated temperatures. Furthermore, the authors investigated the performance of okra fiber samples extracted from various parts of the plant’s stem. Results demonstrate that fibers from the upper part of the okra stem show higher breaking strength and lower linear density, whereas water retting resulted in higher breaking strength, higher rates of elongation at break, and lower linear density values. The thermal characteristics of all samples were similar, and the differences between the types of fibers were rather small.

The third paper, “Basalt Textile-Reinforced Vinylester and Epoxy Resins for Anchors Used to Fasten Ventilated Building Facades”, authored by Majka, T.M., Byrdy, A. and Pielichowski, K., aimed at obtaining insulation composite anchors based on basalt textile-reinforced vinylester and epoxy resins for fixing heavy building elevation cladding [6]. In detail, this paper presents a study on the influence of the type of basalt reinforcement (in the form of textile, chopped fiber and powder) on the mechanical and functional properties of vinylester and epoxy compositions towards potential applications as construction anchors to fasten building facades. The results reported by the authors draft further considerations related to the applications of vinylester resin/basalt and epoxy resin/basalt composites as alternative construction materials to commonly used steel and aluminium.

The fourth paper, “Environmental Consequences of Closing the Textile Loop—Life Cycle Assessment of a Circular Polyester Jacket”, authored by Braun, G., Som, C., Schmutz, M. and Hischier, R., aims to stress awareness regarding the environmental impact of textiles by proposing the wear2wear™ initiative, a collaboration consisting of multiple companies aiming to close the loop for polyester textiles [7]. In particular, a life cycle assessment study was conducted in this work so as to compare the environmental impacts of a circular vs. a linear workwear jacket. The results of this study show that a thoughtful “circular economy system” design approach can result in significantly lower environmental impacts than linear product systems. At the same time, the authors demonstrated the necessity for life cycle assessment practitioners to go beyond a simple comparison of one product to another when it comes to circular economy, because such products require a wider system analysis
approach taking into account multiple loops, having interconnected energy and material flows through reuse, remanufacture, and various recycling practices.

The fifth paper, “Bio-Based Polyester Fiber Substitutes: From GWP to a More Comprehensive Environmental Analysis”, authored by Ivanović, T., Hischier, R. and Som, C., addresses the topic of bio-sourcing for synthetics, notably polyester fiber, in the effort to break from the proven fossil-fuel dependency and decrease the environmental impacts. In particular, their work explores the possibility of replacing traditional fossil-based polyethylene terephthalate polymer with three bio-based alternatives: bio-polyester, polytrimethylene terephthalate, and polylactic acid fibers [8]. The research fills a gap in the scientific literature where there are a lack of studies on the environmental effects of such substitution. Therefore, the authors performed a comparative, cradle-to-gate life cycle assessment of conventional polyester and those substitutes featuring varying levels of bio-content. The impact assessment was performed with the most recent version of the Environmental Footprint method including some adaptations—using carbon crediting and a different, distance-to-target weighting approach. The authors tested nine different substitutes and demonstrated that three of them performed comparably, while the rest performed significantly worse than the incumbent fiber.

3. Future Research

Although this Special Issue is now closed, more in-depth research in innovative textiles in the era of the circular economy is expected in the near future. The current situation in Europe and the United States strongly suggests that industrial processes will undergo an ecological transition, and the textile industry will be increasingly called upon to play a relevant role. CE approaches for the textile industry [9], the design of new generations of yarns [10], fabrics, and garments, using regenerated wool and sustainable materials, the design of textile products improving health and wellness [11], the development of ecofriendly/sustainable processes for fabric manufacturing [12], and the ideation of smart and bio-materials are just some of the keywords for the future of textiles. Such research fields could also embrace recent trends in artificial intelligence methods for the purpose of modelling and simulating circular textile processes [13], for sorting or selecting raw materials [14], for traceability of the textile and clothing supply chain [15], and many more.

As a result, researchers in this field are being asked to collaborate in a rapidly changing environment by bringing innovative research that can contribute to improving well-being and reducing the anthropogenic effect on our (so far unique) world.

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