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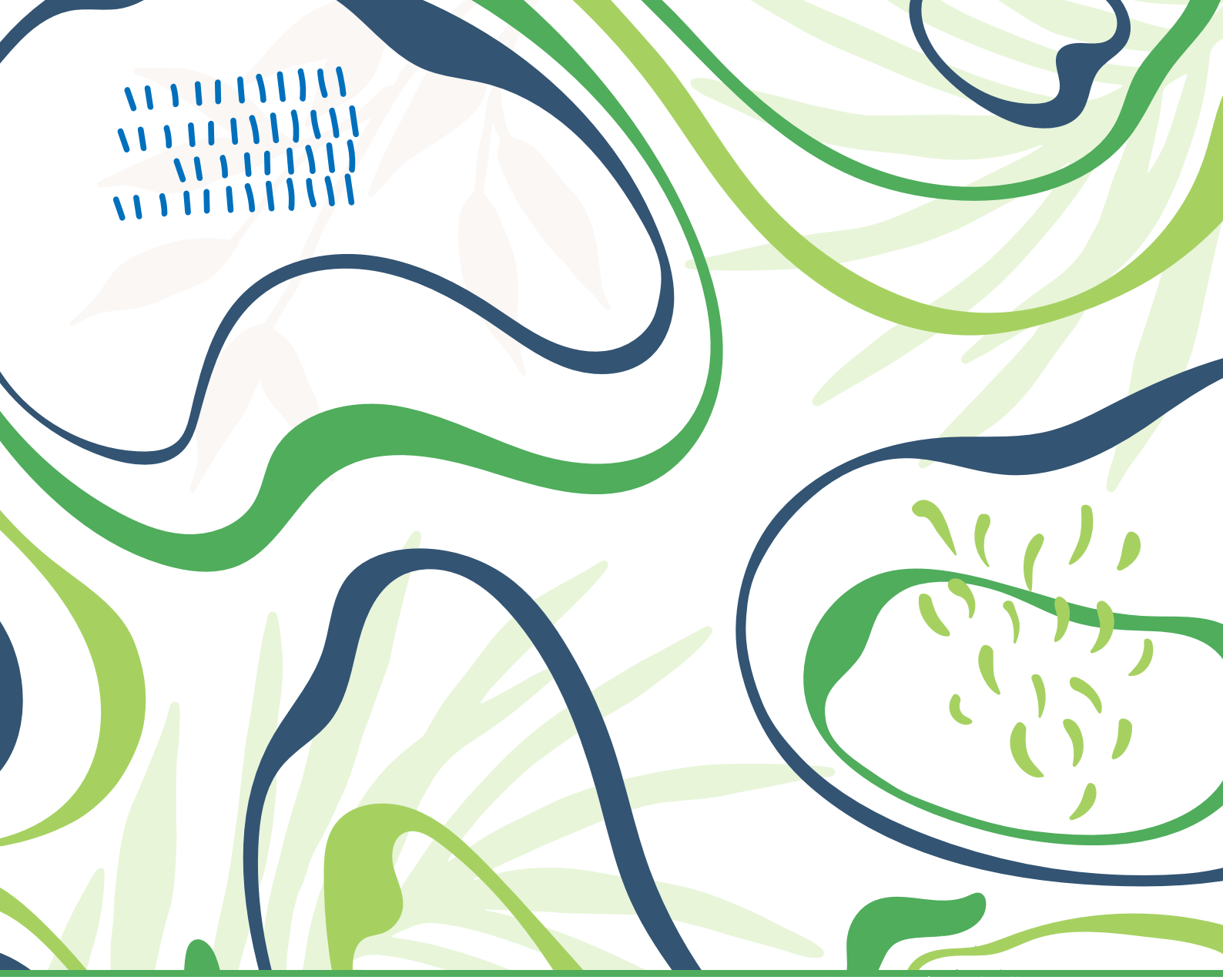

ICNF 2021

5th International Conference on Natural Fibers

Materials of the Future

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Book of Abstracts

Edited by R. Fangueiro

ICNF 2021
5th International Conference on Natural Fibers
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FOREWORD

The International Conference on Natural Fibers is established as the leading scientific event on fields related to natural fibers, from harvesting to its application in high demanding areas. Over the last 4 editions, this event has assumed a very important worldwide position, addressing and defining the most important trends in the field, as an outcome of the high quality of the research works presented and of the strong interaction among the participants.

With a very transversal view on the extraction, processing, functionalization and use of natural fibers, including linen, wool, silk, hemp and cotton, ICNF2021 focuses, in this edition, on the topic “Materials of the Future”, clearly assuming the fundamental role of these materials in building a more sustainable future. In fact, areas such as automobiles, aeronautics, fashion, civil construction, architecture or health-care, have been benefiting strongly from the scientific advances occurred in the last decades in this field, focused mainly on the combination of intrinsic characteristics associated with sustainability and the performance provided by these materials. Biocomposites for use in automobile and aircraft components, geotextiles for use in soil reinforcement, nanocellulose for use in medical devices and fibers for reinforcing construction mortars, are just some examples of fundamental themes for the use of advanced natural fibers. In this context, nanotechnology is also of particular importance in the search for the most appropriate solutions for specific applications, in a logic of multiscale analysis of materials, with a view to their manipulation at the nano, micro and macro scales. Over the last few years, intensive research has been developed to turn natural fibers into smart solutions being able to respond to external stimuli, in addition to their intrinsic sustainable features.

ICNF2021 is covering a wide range of trends defined for natural fibers, with particular emphasis on nanocellulose based fibers and structures, fiber surface treatments, functional natural fibers, smart natural fibers, environmental impact, ecocomposites, biomimetics, and, of course, product development based on natural fibers.

ICNF2021 is the meeting point for all those interested in these fantastic materials called Natural Fibers.

Guimarães, 14th May 2021

Raul Fangueiro
Conference Chairman

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NATURAL FIBERS INSULATION MATERIALS: USE OF TEXTILE AND AGRI-FOOD WASTE IN A CIRCULAR ECONOMY PERSPECTIVE

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ABSTRACT

Fibrous-based materials are among the most used for the thermal and acoustic insulation of building envelopes and among the ones with the best flexibility in use. In building construction, the demand for products with low environmental impact - in line with the Green Deal challenge of the European Community - is growing, but the building market is still mostly biased towards traditional products, missing the many opportunities for using waste materials from existing industrial production. The paper presents the experimental results of new thermal and acoustic insulation products for building construction and interior design, based on previous experiences of the research group. They are entirely produced using waste sheep's wool as a "matrix" and other waste fibers, as "fillers". Proposed materials derive from textile and agro-industrial chains of Piedmont region and have no other uses, different from the thermal valorization as biomass. The panels have characteristics of rigidity, workability, and thermal conductivity that make them suitable for building envelope insulation.

INTRODUCTION

In 2017 in Italian building regulations have been introduced the CAMs (Minimum Environmental Criteria), which are environmental requirements defined for the various phases of the purchasing process, aimed at identifying the best design solution, product, or service from an environmental point of view, along the life cycle. The consequent growing demand for low-environmental-impact building products often does not match adequate availability in the building market. Fibrous-based thermal and acoustic insulation panels are a clear example of building products that could be produced using almost exclusively by-products from already existing industrial production chains, meeting the CAM requirements.

The paper presents innovative solutions in the use of natural fibers for the production of insulating panels, exploring the use of waste materials available in the agri-food and textile production chains. The AGROTESs panels production concept aims to close existing production cycles in a regional industrial system (Piedmont Region, Italy), avoiding the disposal of fibrous waste and reintroducing them into a new production cycle, in a circular economy perspective. AGROTESs panels combine wasted sheep's wool from regional sheep farming and other waste materials like rice straw, chopped corn, fibrous wastes from textile productions.

Proposed rigid panels consist of a keratin “matrix” and a fibrous “filler”. Their production process come from research works, previously carried on at DAD of Politecnico di Torino and CNR-ISMAC of Biella (Piedmont) (Pennacchio et al. 2017), and use keratin in wool fibers as a binder, through a thermochemical fusion in a caustic soda bath, keeping unaltered the main chemical and physical characteristics of employed materials. Further research development recently led to test new waste materials, coming from Piedmont region agro-food production chains, to be used as a filler, as an alternative to hemp, adapting the production process - materials percentage, concentration of soda solution, drying process - according to the specific features of

new selected materials, which also give the panels different density and rigidity characteristics. Among the various local "fillers" experimented during laboratory tests, rice straw fibers and chopped corn showed better compatibility with wool fibers, and their use have been further investigated. At the same time, a different panels' production process have been developed, using powders from wool textile chains, with high keratin content, with no need of mixing with coarse wool fibers.
Research mainly focused on Piedmont region, but could be extended and adapted to other areas with high availability of coarse wool.
Test and measurements have been provided on experimental samples in order to identify opportunities for the production of new low environmental impact products, suitable for the building sector and meeting the CAM requirements and European Green Deal challenge for nearly zero-emission productions.

RESULTS AND CONCLUSIONS

The paper presents, as a result of the experiments on different natural fibers and waste materials, the production process for the production of the insulating panels' samples. In the process, the keratin in wool fibers acts as "matrix" which glues the different "fillers" in treatment with caustic soda. Quantity of components, times, and phases of the production process has been tested and optimized to obtain the densities and physical-technical performances necessary for the use of the panels as well-performant insulations for in construction.
Unidirectional steady-state thermal performance measures (tab.1) obtained through laboratory tests carried out using the guarded ring hot plate method (ISO 8302:1991; UNI EN 12667:2002) show thermal conductivity values slightly higher if compared with those found in previous experimental panels and those of natural insulation products on currently the market (Pennacchio et al. 2017).

Table 1 AGROTESs samples measured thermal characteristics

	Dim [cm]	Mass [g]	Bulk Density [kg/m^3]	λ [W/mK]	R [m^{2}K/w]	U [W/m^{2}K]
AGROTESs A	15x15x3.5	161	204	0.054	0.648	1.543
AGROTESs B	15x14x3.5	141	249	0.063	0.429	2.331
AGROTESs C	15x15x2.2	134	203	-	-	-
AGROTESs C$_1$	14.5x13.5x2.2	136	240	0.061	0.475	2.105

Nevertheless, their high bulk density would make interesting the evaluation of panels' dynamic thermal behaviour. Results obtained, however, eventually open to the possibility of further improving the thermal conductivity performance, through calibrated pressing systems during panels' production.
AGROTESs insulating panels are suitable for multiple uses in architectural field, both in new construction and rehabilitation processes, as for building envelope insulation, as for internal partitions, offering good workability and adaptation to traditional anchoring systems (Savio et al. 2018).

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REFERENCES

[1] Pennacchio R, Savio L, Bosia D, Thiebat F, Piccablotto G, Patrucco A, Fantucci S. Fitness: Sheep-wool and hemp sustainable insulation panels. Energy Procedia, Elsevier, 2017, 111, p. 287-297.
[2] Savio L, Bosia D, Patrucco A, Pennacchio R, Piccablotto G, Thiebat F. Applications of building insulation products based on natural wool and hemp fibers. In: Fangueiro R, Rana S (ed) Advances in Natural Fibre Composites. Springer International Publishing, 2018 p. 237-247.

[3] Tonin C, Patrucco A, Ramella Pollone F., Bosia D, Savio L, Giordano R. Processo di lavorazione della lana, materiali di lana prodotti con detto processo e articoli comprendenti detti materiali di lana. Italian Patent 0001410156. 2011 September 5th 2014GE2012A000029.
[4] ISO 8302:1991 “Thermal insulation - Determination of steady-state thermal resistance and related properties - Guarded hot plate apparatus”.
[5] UNI EN 12667:2002 “Prestazione termica dei materiali e dei prodotti per edilizia - Determinazione della resistenza termica con il metodo della piastra calda con anello di guardia e con il metodo del termoflussimetro - Prodotti con alta e media resistenza termica”.
[6] UNI EN ISO 13786:2008. Thermal performance of building components—Dynamic thermal characteristics—Calculation methods.
[7] Dissanayake DGK, Weerasinghe DU, Thebuwanage LM, Bandara UAAN. An environmentally friendly sound insulation material from post-industrial textile waste and natural rubber, Journal of Building Engineering, Volume 33, 2021, 101606, ISSN 2352-7102.
[8] Wang Y. Fiber and textile waste Utilization, Waste Biomass Valorization, 1 (1) (2010), pp. 135-143.
[9] Seddeq HS, Aly NM, Marwa A, Elshakankery MH. Investigation on sound absorption properties for recycled fibrous materials, J. Ind. Textil., 43 (1) (2013), pp. 56-73.