FUNDING PROGRAMME: EUROPEAN AND INTERNATIONAL COOPERATION

SUBPROGRAME: 3.5: Other European and international initiatives and programs - Eureka Traditional projects, Eureka Cluster

PROJECT TITLE/ACRONYM: Anion-releasing materials with infrared radiation emission - FairTex

CONTRACT NO.: 134/2020

PROJECT TOTAL BUDGET: 1.356.425 Lei (283,895 €) **INCDTP BUDGET**: 379.000 Lei (79,323 €)

START DATE: 1/1/2020 **END DATE:** 1/1/2022

WEBPAGE: http://www.fairtex.ro/

PARTENRS:

1. **MONOFIL SRL** (**CO** -Romania)

2. **The National R&D Institute for Textiles and Leather (INCDTP)**(Romania)

3. **TANEX** (Romania)

4. **Clavis** (South Korea)

5. **Korean Textile Development Institute** (South Korea)

6. **Song I Textile** (South Korea)

GENERAL OBJECTIVE:

The main objective of the project was the development of new textiles that provide health and well-being to users, based on customized multifunctional nanocomposites capable of generating negative ions and far-infrared radiation, as well as protecting the wearer against UV rays and microbial infections.

SPECIFIC OBJECTIVES/ EXECUTION PHASES:

1. Preparation of nanocomposites with high efficiency in far-infrared transmission and negative ion emission, with an average diameter of less than 100 nm and a large specific surface area, to minimize interfacial energies between nanoparticles and the polymer matrix, in order to avoid nanoparticle aggregation.

2. Development of innovative polymer compounding stages with natural (tourmaline) and synthetic (bamboo charcoal, ceramic materials, zeolites) pyroelectric compounds to obtain masterbatches containing a high amount of pyroelectric nanoparticles. The optimized masterbatches were blended with pure polymers to obtain fibers that emit negative ions and far-infrared radiation beneficial to human health.

3. Development of new types of yarns based on synthetic polymers (polyesters, polyamides) and natural fibers (cotton, bamboo) incorporating pyroelectric nanoparticles that generate over 6000–6500 ions/cm³ and emit 90% of far-infrared rays in the range of 5.6–15 µm.

4. Development of pyroelectric textile materials based on the synthesized pyroelectric yarns, both synthetic and natural. The new textile materials will improve general health over the long term, maintain breathability, and remain flexible and lightweight to ensure comfort, wear resistance, and wash durability.

NOVELTY ELEMENTS/ SCIENTIFIC CONCEPT:

1. Obtaining optimized compositions of pyroelectric nanoparticles by combining tourmaline with bamboo charcoal or zeolites, to reduce costs and increase the emission of negative ions and FIR radiation.
2. Development of an improved mixing process to obtain masterbatches with a high concentration of pyroelectric nanoparticles.
3. Achieving an optimal masterbatch/polymer (PET or PA) ratio for uniform nanoparticle dispersion in fibers and obtaining high and consistent emission of ions and FIR radiation (4–14 µm, over 6000 ions/cm³).
4. Creation of soft, comfortable, and modern fabrics by combining the developed fibers with natural fibers (bamboo, cotton) that also generate negative ions.
5. Reduction of costs and medical and environmental impact by improving users' health.

EXPECTED EXPLOITABLE RESULTS:

R1. Technology for preparing nanocomposites with efficient release of far-infrared radiation and negative ions.

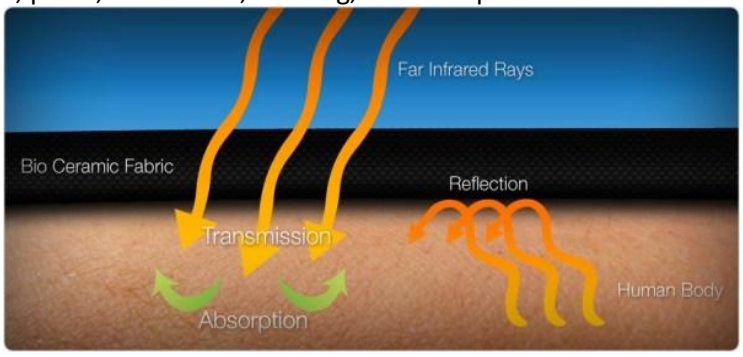
R2. Innovative method for uniform dispersion of nanoparticles in the final textile yarns while preserving their original properties.

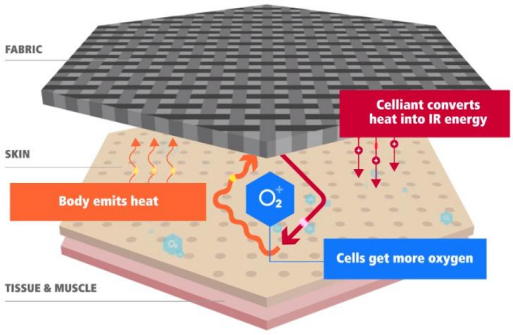
R3. Development of pyroelectric/multifunctional textile materials made primarily from natural fibers (cotton, bamboo).

OBTAINED RESULTS:

1. Study on FIR Functional Materials

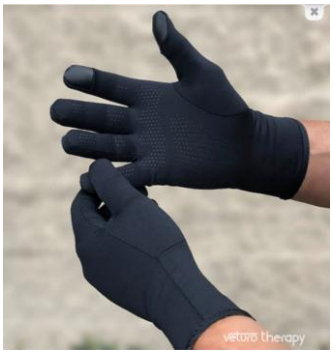
Pyroelectric materials are functional materials capable of generating an electric response to temperature changes. Modern solutions often include a combination of polypropylene and special lead-free bioceramics to create functional FIR garments, which are commercialized in products such as socks, pillows, bed linens, knee pads, pants, bed covers, bedding, shoulder pads etc.





1. Study on the medical applications of FIR technology textiles and definition of end-user requirements

The main ways in which FIR therapy can improve human health are: Increasing blood oxygen levels; Rejuvenating skin and muscle tissue; Promoting regeneration and rapid healing; Enhancing nervous system function; Reducing lipids in the skin; Improving metabolism; Enhancing blood circulation; Improving oxygen and nutrient transport to soft tissues; Removing accumulated toxins through improved lymphatic circulation; Muscle relaxation.

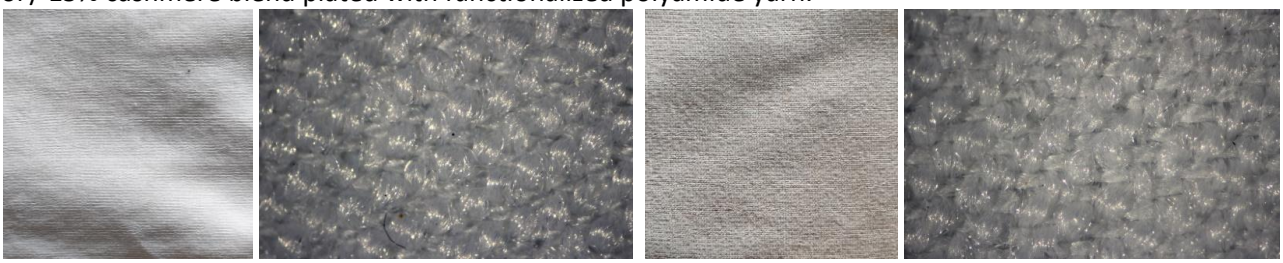


3. Development of textile prototypes from yarns functionalized with FIR property masterbatches

The functionalization materials for the developed textile structures used in the project were created by Clavis (Korea) through the blending of functional inorganic particles into PET and PA. Thus, the following functionalizing agents were obtained: FIR + antimicrobial (PET MB chips – 20 wt%) (a); FIR + antimicrobial + UV protection (primary PET MB chips – 25 wt%) (b); and FIR + antimicrobial + UV protection (secondary PET MB chips – 25 wt%) (c).

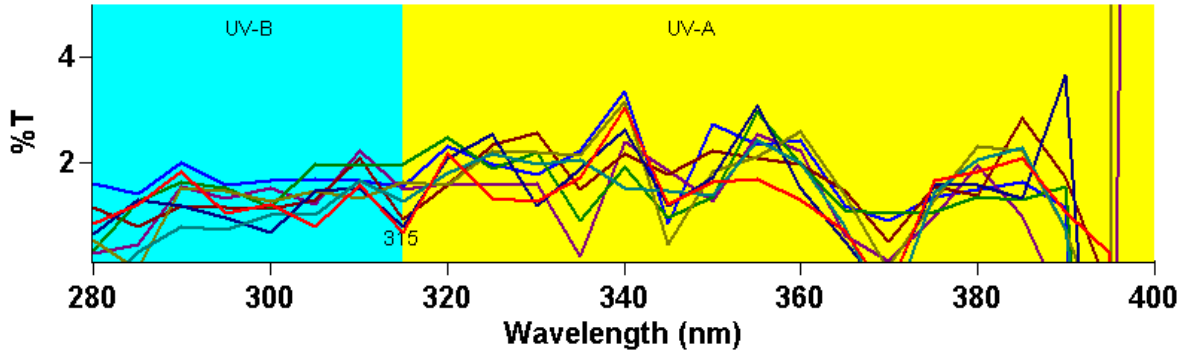
a b c

At the initial stage of the project, two knitted supports with plated jersey structure were developed: knit 1 – base yarn made of 100% gassed cotton plated with functionalized polyamide yarn; knit 2 – base yarn made of 85% wool / 15% cashmere blend plated with functionalized polyamide yarn.



4. Determination of Sun Protection Factor (SPF)

The sun protection factor (SPF) in textile materials is essential for reducing skin exposure to harmful UV radiation, thereby preventing sunburn and lowering the risk of skin cancer. Textiles with high SPF provide an effective barrier against UV rays, especially under prolonged sun exposure.



Following the determination of the sun protection factor, it was found that both developed prototypes exhibit excellent levels of sun protection (SPF > 50+), with measurements conducted in the 400–280 nm range. Specifically, knit 1 shows an SPF of over 58, while knit 2 has an SPF of over 67.

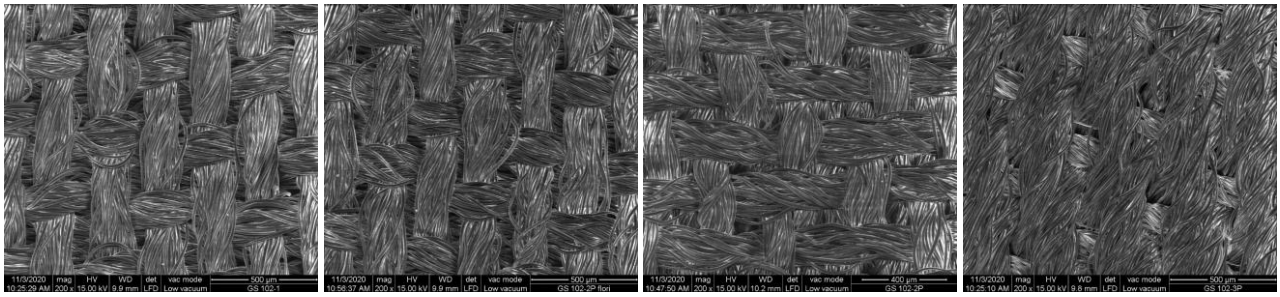
5. Development of functionalized final products and physical-chemical-biological analyses

The final textile materials functionalized with FIR-emitting compounds + UV protection + antimicrobial agents, developed within the project, were characterized from physico-mechanical, physico-chemical, chemical, morphological, and microbial perspectives. The aim was to determine their effectiveness for the intended purpose of the project.

5.1 Material characterization by SEM and EDS analysis

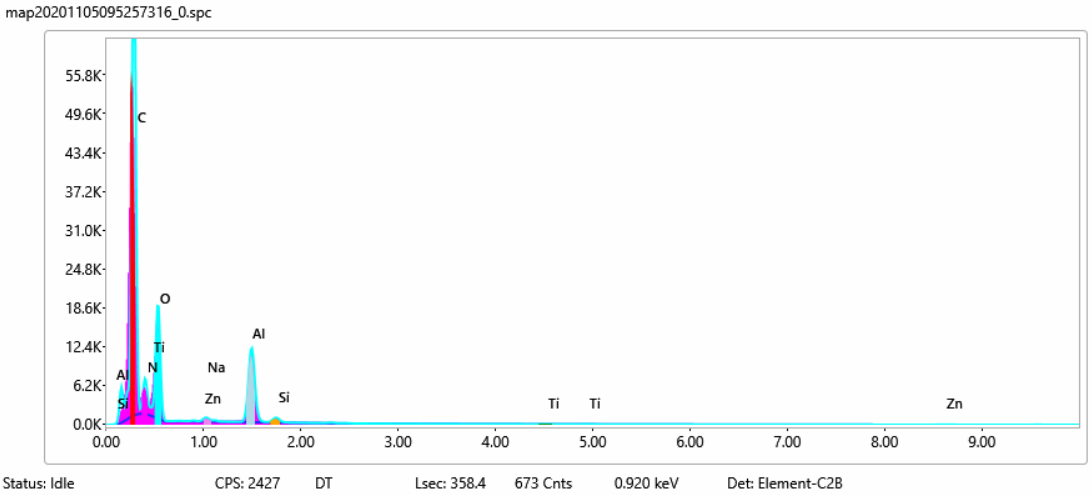
Scanning Electron Microscopy (SEM) provides high-resolution images, allowing spatially close points on the sample to be distinguished at high magnifications. The combination of high magnification, increased depth of field, high resolution, and ease of sample observation makes SEM analysis one of the most widely used tools in current research fields. SEM analysis enabled the visualization of specific morphological features of the analyzed

materials.



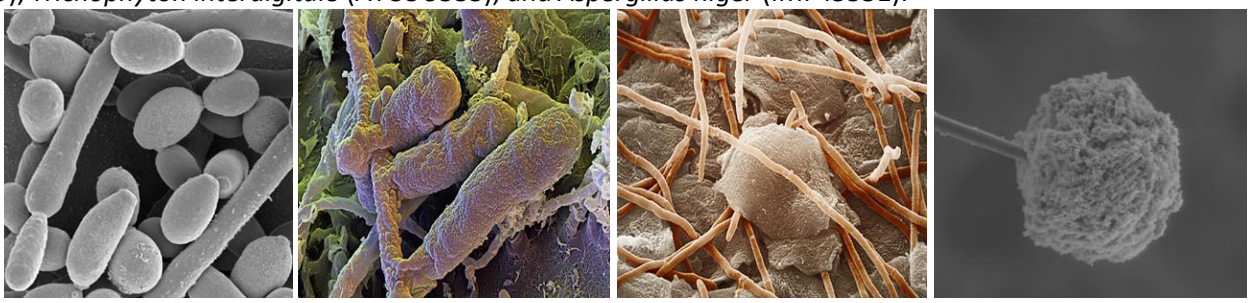
5.2 EDS analysis of materials and quantification of functionalizing compounds

EDS analysis and elemental quantification performed on the four materials highlighted the presence of functionalizing compounds within their polymer composition, varying depending on the material type (composition, dyeing/printing method). Thus, the presence of elements with FIR properties (Zn, Al, Cu, Ti) was demonstrated.



5.3 Evaluation of the antimicrobial properties of the developed textile materials

The antimicrobial evaluation was performed on the four functionalized materials, compared to a control sample (one control per microbial strain, used as the microbial inoculum). Testing was carried out using two methods: one under dynamic contact conditions (with agitation) and one under static contact conditions (direct inoculation on the material), against four microbial strains: *Candida albicans* (ATCC 90028), *Epidermophyton floccosum* (CCM 8339), *Trichophyton interdigitale* (ATCC 9533), and *Aspergillus niger* (IMI 45551).



The results of the static condition tests showed very good levels of microbial reduction, slightly better than those obtained under dynamic conditions. This may be due to the testing method, which allowed for a longer contact time between the microbial inoculum and the functionalized material.

DISSEMINATION, PATENT APPLICATIONS, FAIRS/EXIBITIONS, AWARDS:

- **WoS published papers: 2**

1. Ovidiu Iordache, Elena Cornelia Mitran, Irina Săndulache, Maria Memecică, Lucia Oana Secăreanu, Cristina Lite, Elena Perdum. An Overview on Far-Infrared Functional Textile Materials. The 8th International Conference on Advanced Materials and Systems ICAMS 2020, Book of Proceedings, Vol. 1, pg. 77, https://doi.org/10.24264/icams-2020.I.9.

2. Ovidiu Iordache, Elena C. Tănăsescu, Irina Săndulache, Cristina Lite, Lucia O. Secăreanu, Elena Perdum. Antimicrobial Activity of FIR Functionalized Textile Materials. Book of Proceedings, „Tex Teh X – International Conference on Textiles and Connected R&D Domains", 2021:391-397, http://dx.doi.org/10.35530/TT.2021.57.

- **Scientific communications: 2**

1. Presentation: An Overview on Far-Infrared Functional Textile Materials. The 8th International Conference on Advanced Materials and Systems (ICAMS 2020). Author: Ovidiu Iordache.

2. Presentation: Antimicrobial Activity of FIR Functionalized Textile Materials. Tex Teh X – International Conference on Textiles and Connected R&D Domains. Author: Ovidiu Iordache.

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