Review Article

Bioceramics in textiles: NewFar infrared textiles medical applications

ABSTRACT

In this survey, the concept of bioceramics as a technique or material related to smart textiles, highlighting its main qualities to obtain beneficial effects on health will be studied.
In addition, the integration of electronics in textiles and clothing has opened up a range of functions other than those of conventional textiles and this is what we will see in another chapter focusing on the relationship between textiles smart and wearable systems focusing in particular on "the wearable ECG". This research approach paves our goal for the study of our problem concerning the contribution of these new textiles and techniques to improving lifestyle, comfort and health, specifically among the elderly.

Keywords:Bioceramic, Wearable Smart textile, Medical textile application, Far infrared textiles benefits

1. INTRODUCTION

At the beginning of textile product manufacturing, the aesthetic and decorative features were the main requirement of it, but day by day the demand of man was changed due to the current requirements, nowadays or we can also say during this modern time, man wants to obtain a type of fabrics that have technical and functional properties with their decorative and aesthetic properties at the same time.

Innovation in textiles follows the history of civilizations, man having never stopped looking for new fibers, ennobling and weaving techniques to give this material new properties or reduce production costs. Much more recently, a new generation of textiles has appeared, that of smart textiles.

Intelligent textiles or Smart textiles, these textiles present a relatively new discipline in the textile sector. They are active materials that possess sensing and actuating properties which makes their potential greater than other types of textiles.

We find this new form of textile mainly in the field of fashion and clothing followed by a variety of innovative and creative projects. However, smart textiles are not necessarily destined to become clothing. The latter present a challenge in several areas that we will mention and research them in the first part, citing their main characteristics that help to revolutionize these areas.

In another part, we will study the concept of bioceramics as a technique or material related to smart textiles, highlighting its main qualities to obtain beneficial effects on health.

In addition, the integration of electronics in textiles and clothing has opened up a range of functions other than those of conventional textiles and this is what we will see in the conceptual part focusing on the relationship between textiles smart and wearable systems focusing in particular on "the wearable ECG". This research approach paves our goal for the study of our problem concerningthe contribution of these new textiles and techniques to improving lifestyle, comfort and health, specifically among the elderly.

We ask relatively these questions: Can we consider this innovation an intermediary for the birth of a new sector? And what are its capacities to benefit the health sector and the comfort of the elderly?

2. MATERIAL AND METHODS

The history of textiles is almost as old as that of human civilization and over time it has been further enriched. The first attempts to manufacture textiles aimed to protect the human body from bad weather and external aggressions. The first textile garments were worn at least 70,000 years ago and possibly much earlier such that the garments have long acted as a "protective barrier"

Nevertheless, mainly and historically the textile is exploited afterwards, in two areas: the interior of homes (household linen, furnishings) and clothing (clothing).

This is the case of the textile industry, which presents one of the largest industries in several countries and even among the largest in the world, such that textiles represent approximately 20% of total industrial production. According to the “BREF” relating to the textile industry: “The textile industry chain is one of the longest and most complicated in the manufacturing sector. It is a fragmented and heterogeneous sector, dominated by SMEs (small and medium-sized enterprises), in which demand is driven mainly by three major end uses: clothing, furniture and industrial uses”[1].

2.1 Definition

A textile is defined according to the National Center for Textual and Lexical Resources as a "Material suitable for being transformed into yarn, then woven"[2], this means that a textile is a material that can be woven or knitted.

Textiles can be assumed to be the products of textile fibers that have been processed and woven, which refers to any material made of interwoven fibers. It therefore designates a material that can be divided into fibers or textile threads.

2.2 Origin and categories

Since the art of spinning has existed, which consists of forming threads by assembling and twisting fibers, man has very quickly developed increasingly intelligent and innovative techniques.

Textile materials are generally classified into three main categories according to the fiber and according to their origin: Natural, chemical and inorganic.

2.3 Types or classes of textiles

With new synthetic fibers and the combination of numerous textile or related skills (nonwovens, composites), textiles are expressed today in a renewed spirit and come in new geometries.

2.3.1 Traditional textiles

The first textiles to be worn by man without any innovation in the process of their manufacture or intervention which includes their functionality, this is what we called "Traditional Textiles" these are the textiles for which attention is paid to the appearance and comfort. Traditional textiles are simply

2.3.2 Technical textiles

When the manufacture of textiles meets an intervention of materials and innovative manufacturing processes, we note that these textiles are different from others and this is what we call "Technical textiles". These textiles are characterized by their integration into a vast field of applications which makes them difficult to see because they are most often integrated into other materials and used as semi-finished products within other sectors of activity.

In addition, we address this explanatory definition: “A Technical Textile is defined as any textile product or material whose technical performance and functional properties prevail over aesthetic or decorative characteristics”[3]. This explains that technical textiles differ from traditional textiles since the aesthetic and decorative side is not the main asset.

Technical textiles appear more functional, they are able to be more utilitarian in a variety of applications, to intervene in several areas thanks to synthetic fibers, the latter also enter into the composition of more technical articles such as ropes, nets and hygiene products, creating new markets for textiles for technical use. They also provide new solutions for other sectors. We find this class of textiles even in packaging, transport, interior design, construction (building materials of computer tools or even in building components), we also mention the health sector (medical), the agriculture and geotextile sector, sport and leisure…

However, "technical textiles" are presented as a specific sector of activity, but this type of textile is more manifested as an extension and broader diversification of the traditional textile sector.

2.3.3electronic textiles

Electronic textiles or (e-textiles) are fabrics that contain electronics and interconnections, providing physical flexibility and typical size that cannot be achieved with other existing electronic manufacturing techniques.

2.3.4 Smart textiles

“Today, a 'new frontier' has to be conquered, that of so-called 'intelligent' textiles, ie capable quite simply of interacting with their environment[4].

These textiles are the last class of man-made textiles, a highly developed and innovative form that is still practically in prototype form today but we find a variety of examples of products made by these textiles. This is the new trend taken by researchers, engineers and designers.

If we want to make a connection between smart textiles and other categories of textiles, we can conclude that smart textiles are not a subcategory of technical textiles as they can also be used for non-technical applications in the form of clothing. However, these can be a sub-category of functional textiles: which are textiles with additional functions other than the basic textile functions like protection, well-being and fashion (aesthetics).

2.4 Smart textiles

The term "intelligent" is derived from the word "intelligence" which represents "the function by which man has tried to define himself in the scale of beings, that is to say to situate himself in relation to his inferior, the animal, and in relation to its superior, the divinity”[5].

On the other hand, the two terms “Smart textile” or “intelligent textile” have the same meaning and they are two terms associated with smart materials.

On the one hand, smart textiles can be described as textiles that are able to detect environmental stimuli in order to react to them and adapt to them by integrating functionalities into the textile structure. So this means that these are textile materials that are sensitive to the environment.

According to the CEN[6] definition, there are two main and distinctive functions of intelligent textile materials and systems so that they can have this ability to interact with their environment. The first is the communication function and the second is called the energy function which we will explain them successively:

- External communication function through actuators, sensors and an information management device,

- Energy function driven by different factors such as optical fibers, conductive yarns, thermal heating, fluorescent textiles thanks to specific properties provided by the material, its composition, its construction or its finish. »

On the other hand, these textiles can be defined as textiles integrating, for example, fibers or reactive sensors which are capable of analyzing changes in the surrounding environment in order to provide technical or industrial objects or even physical persons with appropriate responses or even to transmit this information to a processing system.

Indeed, advanced materials, such as breathable, flame-retardant or ultra-resistant fabrics, are not considered smart, no matter how high-tech they are.

Smart textiles represent a relatively new discipline in the textile sector. They are active materials that possess sensing and actuation properties, we assume they have enormous potential.

2.5 Intelligent textiles or Smart textiles and Intelligent materials or Smart materials

"Smart textiles" is the English translation of the term "intelligent textiles", these two terms are often used by researchers in their projects and articles, and especially in the field of technologies developed more specifically in the textile field, although we can notice the emergence of these two terms in other fields thanks to their belonging to intelligent materials.

In order to understand these two terms, we can introduce a new term which is no further from their meaning, it is “intelligent materials” or even “Smart materials”.

On the one hand, we start with this definition: "Smart materials are new generation materials surpassing the conventional structural and functional materials"[7], "Smart materials are new generation materials surpassing conventional structural and functional materials" so these materials are more developed than the materials we know, it is a high range of highly developed and intelligent materials since it has the power to feel and sometimes to adapt to its environment. The difference between the materials mentioned in the previous definition is explained in a sort of explanatory diagram and detailed in the following figure.

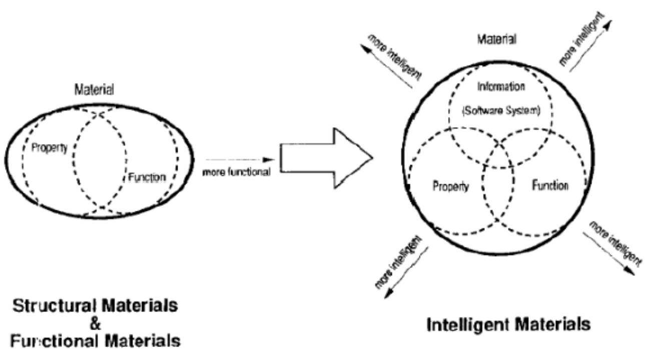

Fig. 1. Structural and functional materials versus smart materials

This diagram presents the characteristics of each material which differs among others. Structural and functional materials basically have two fundamental characteristics, which are property and function. But for smart materials other than their properties and functions, they have several other characteristics including sensors, processor, effector and feedback functions.

On the other hand, Takagi explained them as “intelligent materials that react to environmental changes under the most optimal conditions and reveal their own functions depending on the environment. [8],

We find that smart materials reveal their own capabilities in the environment that make them adaptable to the presence of the exact conditions. And like what we have said and what we are going to say again, these materials have the ability to adapt to external stimuli, and the same is true for smart textiles.

Indeed, smart textiles are an example that clearly demonstrates the overall idea of smart materials, which, on the other hand, represents them as a precise and detailed illustration. This is an example that questions the properties of smart textiles.

2.6 Classification and properties of smart textiles

First we will take as a basis this explanation "The term smart textile describes a class of apparel that has active functions in addition to the traditional properties of clothing"[9], "The term smart textile describes a class of clothes that has active functions in more of the traditional properties of the garment”. This short description shows that these textiles belong to a very high class of innovation. They have very developed capacities which can be more than the protection of the body of the external aggressions or even more of its decorative role which has been the case for a long time.

The only definition that can express simply and generally the meaning and main role of smart textiles is that they are: textiles capable of detecting and reacting to changes in their environment. This ability is due to their intelligence.

The range of intelligence can be divided into three subgroups:

- Passive smart textiles that can only detect or sense the environment, what we call “sensors”. This kind of smart textiles has the ability to modify its properties according to environmental stimulation.

We cite as examples shape memory materials or (Shape memory materials, “SMMs”[10], hydrophobic or hydrophilic textiles[11]… which are part of this category.

- Active smart textiles that can sense and react to environmental stimuli, besides the sensor functions, they also have an actuator function. So these smart textiles are equipped with sensors and actuators to connect the internal parameters to the transmitted message. They are able to detect different signals from the environment such as temperature, light intensity and pollution to decide how to react,in order to react with different textile-based, flexible or miniaturized actuators, we cite, for example, textile displays, micro-vibration devices, light-emitting diodes (LED), organic light-emitting diodes (OLED), etc.

- Finally, the highly intelligent textiles that are developed even further. The latter have the potential to adapt their behavior according to the circumstances proposed by the environment which surrounds them, we mention thermoregulating textiles as an example for this last kind of intelligent textile.

Indeed, smart textiles are structures capable of detecting, reacting and adapting to a large number of stimuli: electrical, magnetic, thermal, optical, acoustic, mechanical, chemical... And these are exceptional properties that make them more capable than other types of textiles.

2.6 Areas of integration of smart textiles

. The particular characteristics and qualities of smart textiles potentially offer very interesting perspectives in several areas.

We can find this new generation of textiles or what we call "the textiles of the future" in the field of health (medical applications), the field of transport and energy, the field of protection and security and even the field of communication. , in the construction of buildings, in engineering…

2.6.1 Different areas

We will take a few areas to explain the form of the presence of smart textiles in each of them, led by examples.

In the field of engineering, which is certainly a rich and vast field, we find as examples, "fiber optics" which have long been used and classified as a form of intelligent textiles which serve several purposes, not just for the field engineering, but in many other fields. Figure 2 illustrates an example of fiber optic applications in engineering.

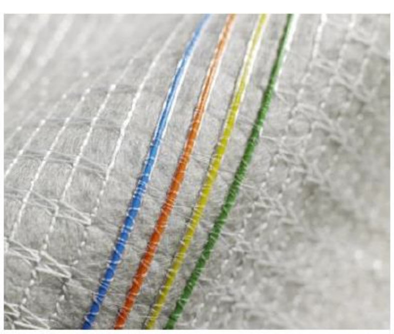

Fig. 2. Sensor integrated into geotextiles for temperature and deformation measurements.

In the field of architecture and construction, the use of smart textiles is relatively new. We find this form of innovation in the example of the Shanghai airport, which uses a geotextile with water-swellable bentonite on the walls of the basements, to protect it from water and damage caused also by water.

Another area that we want to indicate in this report and which is supposed to be an area that encounters low application of smart textiles but that does not make it less interesting to mention here. According to the book entitled "Textile Advances in the Automotive Industry" or "The progress of textiles in the automotive industry" several innovations concerning this sector since it contains an important part (chapter) on intelligent textiles in automotive interiors.

Smart textiles containing nano sensors placed inside the car. The latter could potentially be used to detect different actions, for example the posture and gestures of the passengers and the driver. We take for example, the safety air bag control system which may contain sensors and actuators, which are interconnected via an air bag deployment control device.

2.6.2 Smart textiles for medicine and health

Smart textiles for health include textile sensors, actuators and wearable electronic systems embedded in textiles that enable the recording and transmission of physiological data, as well as wireless communication between the wearer (patient) and the operator (doctor).

This new technology and these systems thus offer a higher level of psycho-physiological comfort, in particular when long-term bio-monitoring (BSH or HBM) is required. These systems ensure patient mobility and this is the most great advantage over other medical devices and solutions.

In general, the integration of smart textiles in medicine and healthcare ranges from simple wire-based surgical applications to complex wearable and auxiliary systems for more personalized healthcare.

To further explain the strong presence of smart textiles in the field of medicine and health, we take as a proposal this table, which shows this presence of these textiles in each application and which are taken by examples to understand[12].

Table 1. Applications of smart textiles for medicine and health

Application	In vitro	In vivo
Surgery	Bandages Wound-care	Sutures Soft-tissues Orthopaedic implants Cardiovascular implants
Hygiene	Uniform for medical personal Hospital textiles	-
Drug-release systems	Smart bandages and plasters	-
Bio-monitoring	Cardiovascular and haemodynamic activity Neural activity Muscle activity and kinematics Respiratory activity Thermoregulation	-
Therapy and wellness	Electrical stimulation therapy Physiotherapy Auxiliary systems Active thermoregulation systems	-

2.6.3 Smart textiles for pregnancy

Most pregnant women do not need to constantly monitor their vital signs and visit their doctors or hospitals very often. However, women with high-risk pregnancies prefer to be in control of their cases to prevent certain problems or risks that can put them or their babies at risk.

So, a fetal monitor that measures the baby's vital signs will be a very important tool in assessing the well-being of the fetus. Several new achievements (projects) that we have found, have made prototypes of products that are interested in detecting and monitoring the main physiological parameters of the mother and the fetus but in a way that the product will be in fabric and wearable at the time. It can make the mother more comfortable and assured.

This kind of the products is usually made by smart textiles, the fabric makes these wearable technologies to be more comfortable and flexible when using.

In order to allow early detection and immediate warning of fetal development or pregnancy complications, we find for example: a knitted smart garment that will comfortably monitor uterine activity and fetal ECG wirelessly.

2.6.4 Smart textiles for hospitalized children

On the one hand, today's monitoring methods in medicine are not always suitable for children. This textile evolution can be a solution for children in particular. In general, monitored children cannot move freely because of the wires that connect the sensors to the corresponding equipment in health centers or hospitals. By integrating sensors, interconnects, antennas and electronic components into the garment, we can, in this case, obtain a self-contained suit suitable for children.

On the other hand, the part concerning the design of the product plays a very necessary role, generally how to take care of children during health examinations which sometimes require the use of medical devices with sensors linked to the human body. In this case, the attraction that the aesthetic part of the design has can fascinate the child and affect his behavior, unlike the traditional methods that we find in medical centers.

2.6.5 Smart textiles for older people

The aging of the world population and the increase in its average life expectancy are becoming a social and economic problem for society.

Today, smart textiles can be an interesting tool that helps to improve the lifestyle of people in need of medical treatment, to rehabilitate after medical treatment, and to improve the lifestyle of the elderly by assisting the functions of the organization that are in decline. In this context, we find it necessary to propose solutions that allow the independence of the elderly and their mobility to be maintained, more and more, avoiding unnecessary permanence in hospitals and institutions for these people who need more daily monitoring.

3. BIOCERAMICS IN TEXTILES: A TECHNIQUE OR A MATERIAL

The term "bioceramic" or in English "Bioceramic" is a term composed of two words: "Bio" and "Ceramic". Also, bioceramics is a term applied to ceramics with biological functionality, including those that can emit an IRL or FIR[13]. According to the definition of the Universalis encyclopedia: "in technology, ceramic resulting from combustion residues having the power to purify water, used as a substitute material for teeth and bones"[14]., we can conclude that this is a material that has been used for a long time in the field of health, in fact the use of ceramics in medicine and dentistry was initially based on the relative biological inertia of ceramic materials compared to metals.
Furthermore, “Bioceramic is a material that emits high performance far-infrared ray, and possess physical, chemical and biological characteristics on irradiation of water, particularly to in reducing the size of water clusters, weakening of the hydrogen bonds of water molecules and other effects on physical and chemical properties of water”[15].According to this definition we translate bioceramics as "a material emitting high performance far infrared rays and possessing physical, chemical and biological characteristics with regard to the irradiation of water, in particular to reduce the size of the clusters of water, weaken the hydrogen bonds of water molecules and other effects on the physical and chemical properties of water. »
So the bioceramic in this definition is presented in the same way, as a material that has several capacities that we will explain them in this part of our report. These abilities are also brought about by distinctive characteristics of this interesting material.
On the other hand, the term bioceramics can be "a technique" used or applied during the manufacture of textiles. Bioceramic textiles are nanotechnology which, applied to textiles, promotes well-being, blood circulation and postural stability.

3.1The origin and components of the bioceramic material

Bioceramics is a mixture of volcanic rocks heavily charged with metal oxides to reflect infrared. It is an inorganic, non-metallic and polycrystalline refractory mineral.
Bioceramics are used in many types of medical procedures. The latter is part of the biocompatibility of ceramic oxides, which are inert in the body, at the other extreme of resorbable materials, which are eventually replaced by the materials they were used to repair.
For a long time, this material has already been used as a base for prostheses and implants, thanks to its composition which does not cause any reaction in the organic tissues, which reduces the risk of infection to a minimum. However, in recent decades, several researchers have exploited its ability to emit radiation in the infrared spectrum, the far infrared

IRL (Far Infrared). This radiation, when transmitted by bioceramics, is called cIRL and has specific characteristics due to its wavelength.
The bioceramic textile exploits a nanotechnology which, applied to the textile, promotes well-being, blood circulation and postural stability. This type of material does not require an external energy source, since it generates its radiation using the energy released in the form of heat by the organism (the body of the user), which makes this technology not only sustainable and environmentally friendly, but also safe and economical.

3.2 Far infrared textiles: FIR (far infrared radiation) textiles

People have long believed that exposure to the sun can maintain and improve health and well-being and this is what these textiles are able to do (in turn this is the concept of bioceramics).
These materials are based on the principle of absorbing energy from sunlight and then releasing it back into the body at specific wavelengths.

3.2.1 The principles of electromagnetic radiation and infrared radiation "IR"

Solar radiation is composed of cosmic rays composed of highly energetic particles and electromagnetic waves of various wavelengths ranging from short waves which include, gamma rays, X-rays, ultraviolet C (UV-C), to which include ultraviolet B (UV-B), ultraviolet A (UV-A), visible light, infrared (IR), microwaves and radio waves. So electromagnetic waves between visible light and the microwave region are called infrared light.
According to NASA[16]: "Infrared light lies between the visible and microwave portions of the electromagnetic spectrum. Infrared light has a range of wavelengths, just like visible light has wavelengths that range from red light to violet. "Near infrared" light is closest in wavelength to visible light and "far infrared" is closer to the microwave region of the electromagnetic spectrum"[17], this means that "Infrared light is located between the visible and microwave parts of the electromagnetic spectrum. Infrared light has a range of wavelengths just like visible light which has wavelengths ranging from red to violet light. The wavelength of "near infrared" light is closest to visible light and "far infrared" is closer to the microwave region of the electromagnetic spectrum. So, infrared radiation or radiation (RI or RI: Infrared Radiation), which is sometimes called "infrared light", is electromagnetic radiation whose wavelength is greater than that of visible light. It is therefore generally invisible to the human eye.

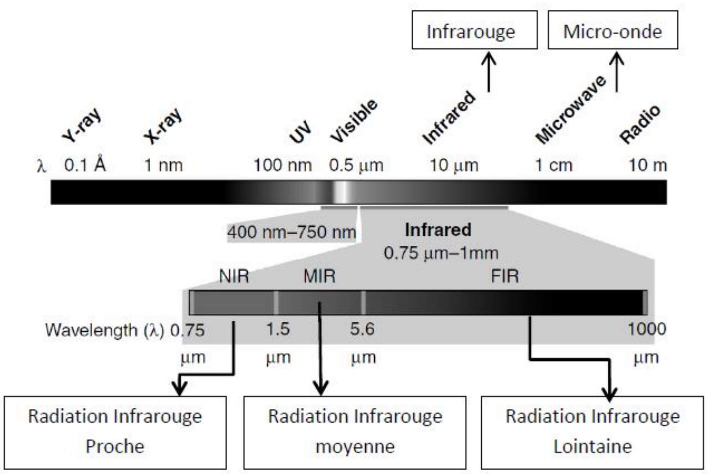

Fig.3. The location and distribution of IR in the electromagnetic spectrum.

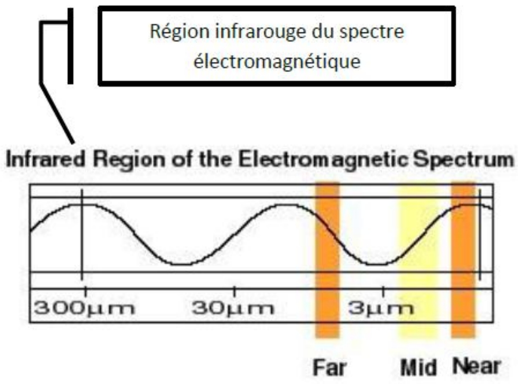

Fig 4. Diagram of the infrared part of the spectrum showing the far, middle and near intervals

The diagram presented in figure 4 and the graph explained in figure 3, show the intervals of the infrared radiations (Far-Mid-Near: Far-medium-near) and the values in micrometers (µm) which divide them. And from this quote: "Infrared radiation is an invisible electromagnetic wave with longer wavelength than that of visible light. According to the difference in wavelength, infrared radiation can be divided into three categories: Near-infrared radiation (0.8 to 1.5 µm), Far Infrared Radiationradiation (1.5 to 5.6 µm), and far-infrared (FIR) radiation (5.6 to 1000 µm)."[18], we find that according to the difference in wavelength, infrared radiation can be divided into three categories: infrared radiation near (0.8 to 1.5 µm), mid infrared radiation (1.5 to 5.6 µm) and far infrared radiation (5.6 to 1000 µm).
In addition, the two key properties of far infrared radiation that directly relate to infrared textiles are the absorption characteristics of human tissue by far infrared radiation and the emission properties of textiles by far infrared radiation as well.
On the one hand, far-infrared textiles are generally derived from traditional fibers, but have been functionalized by incorporating a material with appropriate electromagnetic absorption and emission properties. These textiles are part of this new category of functional and intelligent textiles, which are in turn equipped with a putative health and wellness functionality, with the aim of improving blood circulation in targeted regions of the body. We can affirm this by this short definition: "Far infrared (FIR) textiles are a new category of functional textiles that have putative health and well-being functionality."[19], "Far infrared (FIR) textiles are a new category functional textiles with supposed health and wellness functions".
On the other hand, far infrared (textile) fiber refers to the fiber that "emits" or "gives off" far infrared rays.
According to this definition "FIR textiles are often made through adding nano- or micro-sized ceramic powder to polymers prior to spinning. Bio-ceramic powders that can be incorporated into the structure of textiles to add FIR effects include magnesium oxide, zirconium, iron oxide, silicon carbide and germanium-based compounds"[20], we find that these textiles are made using a modern technology called nanotechnology .
Indeed, nanoscience and nanotechnology are considered the key technologies of this century. Efforts are being made around the world to createsmart textiles by incorporating various nanoparticles or by creating nanostructured surfaces and nanofibers leading to new textile performance.

3.3 The mechanism of bioceramics

The concept of these textiles makes it possible to capture the positive contributions of the sun, the far infrared rays, which reinforce our muscular activity and our tone, to recover part of the loss of energy which escapes from our body in the form of heat and wavelength during exercise and restores
The reflected far infrared generates micro-vibrations which initiate a thermal reaction raising the temperature of the tissues. The body reacts to this phenomenon by dilating the blood vessels and as a result blood circulation will be greatly improved without an increase in heart rate.
Far Infrared Radiation (FIR) fiber is called ceramic fiber (or bioceramic) because ceramic is built inside the fiber, which allows the fabric to absorb body heat and then release a ray far infrared 8 to 12µm wavelength. which is very similar with the human body release wavelength of 9.36µm, so the far infrared ray can penetrate deep into the skin to induce the water molecule to resonate and give out heat which will blood vessels to cause thermal expansion to stimulate blood circulation and metabolism also vitalize cells.

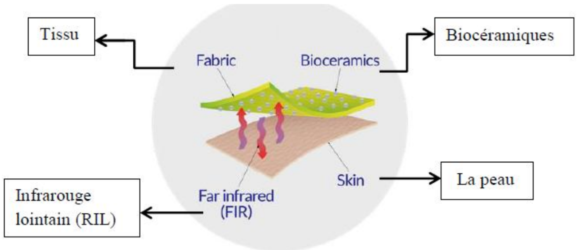

Fig 5. The mechanism of the bioceramic textile (RIL textile) upon contact with the skin.

3.4 The bioceramic coating: Textiles or far infrared fibers

RIL textiles are generally derived from traditional fabrics and in addition bioceramic additives can be incorporated into them using two methods:
- Mixing inside the yarn during the fiber spinning process
- Fixing after surface treatment.

In the first method, ceramic powders are combined with a polymer resin and the yarn is melt spun. The ceramic powders being distributed in the fiber. Bioceramic textiles are often made by adding nanoscale or microscopic ceramic powder to polymers before spinning. On the other hand, the effect that the textile gives with this method is semi-permanent, with excellent resistance to washing and rubbing.

3.4.1 Case study

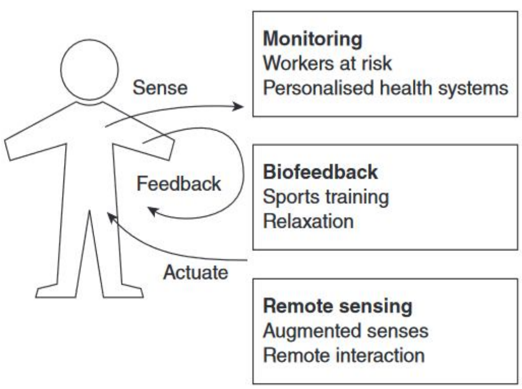

Fig.6. The three directions of data flow

The bioceramic textile exploits a nanotechnology which, applied to the textile, promotes well-being, blood circulation and postural stability. Such as far-infrared textiles, these materials are based on the principle of absorbing energy from sunlight and then releasing it back into the body at specific wavelengths.
Wearable technologies have the ability to automatically recognize their own user's activity and behavioral status, as well as the situation around them, and use this information to adjust system configuration and functionality.
The intelligence of textile materials created by electronics begins with sensors and actuators integrated into the textile in order to make it reactive.

3.4.2 Actuators

« *Actuators integrated in textiles can be used for two purposes – signalling (haptic feedback, light, sound, etc.) or environment control (heating, illumination).* »

The actuator is divided into two parts:
- the first contains information
- the second transfers energy

The electrocardiogram or ECG is one of the most important examinations for monitoring the physiological state of a person. An electrocardiogram (ECG) is a test that measures the electrical activity of the heart. this method is the most accurate and scientific in terms of results, as it provides useful and accurate information on the diagnosis of the cardiovascular system. But its disadvantages are:
- Skin irritation
- Discomfort

- Immobility

3.4.3 Wearable technology examples:

Capacitive coupled ECG (CC-ECG): example of a method for a wearable system: This method is viable providing non-contact ECG, essential for long-term use of the user-sensor interface. The latest development in dry electrode technology. Gold reflect line (Ceramiq): example of a series of bioceramic products. This complex (Bioceramic) makes it possible to contract a new biological property: to capture the rays of the sun as well as the heat of the body, and to transform these energies into far infrared rays.

3.4.4 Proposed Product

Good heart signal from the body without direct skin contact.
Lightness and comfort for the user
Positive consequences for the body (benefits)
make a product dedicated to the elderly since they are more at risk and they need more monitoring and prevention of heart disease and shock.
Combination between two technologies: Bioceramics and portable and contactless ECG.
A wearable system made of smart textiles that seeks to help the elderly and their entourage and to facilitate their lives, protect their health and above all guarantee the comfort necessary for the elderly.
Highlighting the capacity and the important role of the technique or the bioceramic textile in the daily life of the elderly can be a solution for their problems and also for the future of the textile field in general.
Achieving well-being through smart textiles and new technologies is manifested in the system we have proposed and applied in a conformable product for elderly people.

Fig. 7. Proposed portable and contactless ECG T-shirt

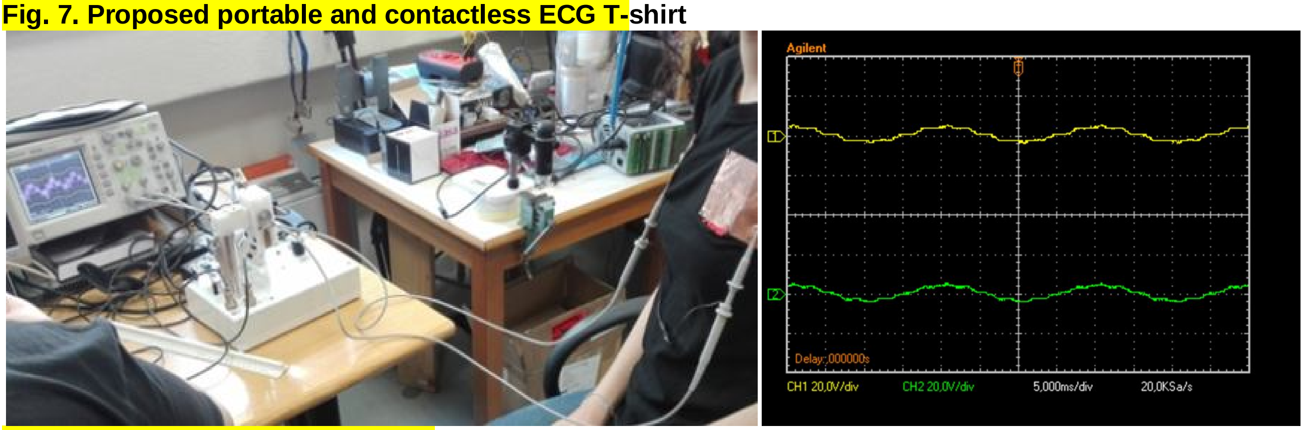

Fig. 8. Experimental measurement

4. CONCLUSION

Finally the Bioceramic in textile materials possess a variety of dedicated benefits for the health and well-being of the human body. “At the molecular level FIR exerts strong rotational and vibrational effects with the potential to be biologically

beneficial."[21], inferring that bioceramics which is based on the RIL concept, exert strong rotational and rotational effects, potentially biologically beneficial
We can mention the example of Far Infrared Therapy, a practical and non-invasive technology, can be an effective therapeutic modality to improve access flow and patency of arteriovenous fistula in hemodialysis patients. According to the research and the results shown in the article by Chihching Lin et al[18], this therapy is based on the use of the electrified ceramic plates of a transmitter which generate electromagnetic waves of a wavelength included between 5 and 12µm. In addition, some studies have indicated that treatment with far infrared radiation can improve endothelial function and reduce the frequency of certain cardiovascular diseases.
On the other hand, the RIL therapy that we have discussed, which is certainly based on the use of ceramics when treating patients, offers a wide range of claimed health and well-being benefits such as:

- Increased oxygen in the blood
- Rejuvenation of skin and muscle tissue
- Promotes regeneration and rapid healing
- Improved functioning of the nervous system
- Reduction of lipids in skin tissues
- Improved metabolism
- Improved blood circulation
- Improved oxygen and nutrient supply to soft tissues
- Removal of accumulated toxins by improving lymph circulation
- Muscle relaxation.

The development of RIL textiles is is a perspective of FIR therapy in general. The bioceramic material which forms a strong relationship with far infrared textiles is able to maintain these aforementioned benefits.

REFERENCES

1.European Commission. Reference document on best available techniques Textile industry, 2003, page 7.
2. CNRTL: National Center for Textual and Lexical Resources.
3.Hemery Y. Etude sur les textiles techniques, Synthesis report, 2006, p. 9.
4.Dubief Y. white paper on smart textiles, 2017, page 2.
5.UniversalisEncyclopedian Accessed 29 March 2023. Available: https://www.universalis.fr/dictionnaire/
6. Dubief Y. white paper on smart textiles, 2017, page 5
7.Susmita K., Introduction, classification and applications of smart materials: an overview, 2013, page 876.
8.Toshinori T. A concept of intelligent materials, Ion Engineering Research Institute Corporation, 1990, page 149.
9.Shishoo R. , Textile advances in the automotive industry, first edition, page 178.
10. SMMs: Shape-memory materials are able to return to their original shape in the presence of an exact stimulus.
11. From the Greek hydros (water) and philos (friend), hydrophilic describes the tendency to love water. The opposite is a hydrophobic treatment.
12.Mecnika V. Smart textiles for healthcare: applications and technologies, 2014, page 152.
13. IRL: Far infrared radiation, FIR: Far infrared radiation
14.Universalis, Accessed 29 March 2023. Available: https://www.universalis.fr/dictionnaire/bioceramic/
15. Ting-Kai L. In Vitro and In Vivo Studies of the Biological Effects of Bioceramic (a Material of Emitting High Performance Far-Infrared Ray) Irradiation, Chinese Journal of Physiology, 2015, page 147.
16. NASA: National Aeronautics and Space Administration
17. Official NASA website, https://www.nasa.gov/audience/forstudents/912/features/F_The_Infrared_Region.html
18.Chih-Ching L, Chao-Fu C, Ming-Yu L, Far-Infrared Therapy: A Novel Treatment to Improve AccessBlood Flow and Unassisted Patency of Arteriovenous Fistulain Hemodialysis Patients, 2007., p.985
19. Dyer J. Infrared functional textile, Woodhead Publishing Limited, chapitre 8, 2011, page 191.
20. Dyer J. Infrared functional textile, Woodhead Publishing Limited, chapitre 8, 2011, page 191.
21. Dyer J. Infrared functional textiles, In: Functional Textiles for Improved Performance, Protection and Health. 2011, page 184.