The Development and Research of the Thermal Material

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ABSTRACT: The year 2016 has witnessed the booming of the thermal material in the field of clothing. Scientists are trying to explore three prime means to make the idea that materials themselves can spontaneously produce heat and warm into reality, including hydrophilic material, solar-energy storage material and phase changing material.
KEYWORD: softwarm fiber, hydrophilic material, solar-energy storage material, phase changing material

1 INTRODUCTION

Long before, the purpose of clothing is to veil body and to keep warm such as crudely made fur and leaves. Around B.C. 5000, Egyptian struck hemp plants with stone in order to soften them, and then tore and knitted those into net-like clothes. Around B.C.3000, cotton are chiefly planted in India. Around B.C.2600, Chinese start to breed silkworm to obtain clothing material--silk. In this sense, we are somewhat constrained by the clothing material, and usually wear heavily to keep warm in the cold weather. The artistic design of the clothes occupy a little in the clothing manufacture.

Nowadays, faced with the rapid development of the modern society, scientists are trying to explore three prime means to make the idea that materials themselves can spontaneously produce heat and warm into reality, including hydrophilic material, solar-energy storage material and phase changing material. If we can achieve it, what we need to do next is to mix this special material with other original material like silk or cotton to create the warm-kept clothes. Thus, producers can spare more energy in the artistic design of the clothing and never be obsessed by the heavy warm-isolated clothing, especially in the cold day. Each individual can wear clothes in their own style, which is actually the ultimate aim of clothes in my opinion.

2 RESEARCH OF THE THERMAL FIBER

2.1 *Hydrophilic material*

First, instead of isolating ourselves from the cold environment outside, such material itself can produce extra heat to increase the temperature of humans. Some endothermic material can do it, which is the latest mechanization to some extent [1]. To be exact, the density of sweat evaporated from the skin motionlessly is around 15 g/(m²·h), whereas they can produce numerous sweat about 100 g/(m²·h) when exercising. According to this, it is obvious that people can produce heat unintentionally even when they do not exercise, so such endothermic fiber can absorb humidity from human's body. The principle of heat producing is that, when water is attached to the hydrophilic groups, its kinetic energy would be transformed into thermal energy [1]. Because of that, the liquefaction of water eventually produce the heat people needed.

Japan do lots of researches to explore such endothermic material. Shimizu Takeo succeeded in attaching more than two aroyl hydrazine group in molecule to the hydraxine derivative, and then apply silica gel and natural moisturizing material to the surface of fiber [2]. Thus, material which can release heat created finally. Moreover, the Eastern Ocean Company develop an advanced mean to hydrophilic the propenoic acid homopolymer by the incursion of -NH2 and -COOH. Since the content of hydrophilic perssad in such fiber are higher than any other natural fiber, since the former enjoy highly hydrophilic characteristic. In order to control the speed better,

the structure of fire can be improved to be moderated to steady the speed of absorbing and releasing moisture or heat [2].

For instance, softwarm fiber is popular material used in the underwear next to the skin. To be exact, softwarm fiber and moisture released from body can produce heat through chemical reaction. Because of the existence of double-lays interval between acrylic fibers and flat rayon, it can act as a wall to avoid the loss of heat. Moreover, the superior touch of this softwarm fiber owes to the special spinning crafts and soft-skin touch of such acrylic fibers which create the unique stereoscopic wrinkle. Hence, it is an excellent choice to be the makings of underwear or sweater.

N38 fiber is another example, which can absorb a lot of moisture up to 41% of its own weight in the 20℃ and 65% humidity. Made from propenoic acid fiber, N38 is modified with polymer and highly hydrophilic finally. At last, this material can not only highly absorb moisture, but also share the characteristics of bad smell elimination, antibiosis and mouldproof. N38 fiber play an essential influence in the field like sportswear, especially ski suit.

Scientists in the Dong Li Company of Japan exploit a new fiber called Warmsensor. By daubing some special material in the surface or interior of fiber, it can release more heat in chemical reaction triggered by the interaction with water molecular. Compared with other ordinary material, Warmsensor fiber can help increase body temperature by 3~5℃, mainly applied in components of sportswear.

2.2 *Solar-energy storage material*

Second, More energy from sunlight strikes Earth in 1 hour than all of the energy consumed by human in an entire year. In fact, the solar energy resource dwarfs all other renewable and fossil-based energy resources combined. With increasing attention toward carbon-neutral energy production, solar electricity or photovoltaic (PV) technology - is receiving heightened attention as a potentially widespread approach to sustainable energy production [3]. Undoubtedly solar energy is an inexhaustible and environmental friendly energy, so it is an appealing practice to transform it into heat. To be exact, the solar energy can be transmitted into electric energy in the process of optical reaction with the help of electronic components or just material itself. The characteristics of such fiber is that this material can absorb solar energy and store it at first and then release heat in a slow process, especially when we need it in certain situation. There are two categories according to the principle of such sunshine-transmitting fiber: one is the combination of solar battery and electric clothing, the other is about sunshine-transmitting material itself [4].

With regard to the former, there exists two transformation involved: the storage of electric and release of heat [4]. As a matter of fact, the plastic solar battery can be applied to the structure of fiber and transform the solar energy into electric power, and then the electric metal wire and thin coating spread on the clothing can transform electric power into thermal energy. To be exact, in the sunlight, the electric tension start to take place in the both ends of semiconductor's p-n, and this phenomenon is called photoelectric effect, which the principle of batteries lays on. There are various kinds of components of the batteries ranging from monocrystalline silicon, polycrystalline silicon, compound semiconductor to organic semiconductor. What's more, the procedure would take place efficiently in solid, liquid, and gas. The operational principle of solar battery, based on photoelectric effect, is radically different from firepower, water power, wind power, nuclear power and others.

The other one, sunshine-transmitting fiber can absorb visible sunlight and short infrared ray to reflex heat radiation, so it can serves as an opportunity to produce heat to human [4]. For instance, exposed to the sunshine, the material attached with metallic carbide of IV group can absorb high radiation from sunlight electromagnetic radiation above 0.6V and transform it into thermal energy. However, such material do not absorb but reflex the other below 0.6V.

2.3 *Phase changing material*

The phase transformation of some material can also produce heat. To be extract, the common process of such transition is divided into solid-liquid and solid-solid. The principle of the first one is that melting process can store heat and then the liquid would release heat when concreting [3]. The key of solid-solid transformation lies in the crystal structure. For instance, the solid structure can change from order into disorder to store and release heat reversibly. Fortunately, there are abundant promising materials like fluride, sulfate, nitrate, ceresin wax and other organic heat reservoir material [3].

There are lots of requirements involved in the selection of the phase transformational material. Since moderate temperature of human bodies range from 29 to 35℃which the region of such material should match. What's more, heat releasing, thermal conductivity and material density also influence the efficiency of the phase transformational fiber. Also, circularity of store and releasing is another significant characteristic, which refers that it need to be a stable process of the phase transformation and require no loss, no change and no excess heat or cold.

The following phase change material (PCM) properties to be used for latent heat storage were highlighted as desirable [5]. To be exact, it would be more preferable if share the characteristics of a

high value of the heat of fusion and special heat per unit volume and weight, a melting point which matches the application, a low vapour pressure (<1 bar) at the operational temperature. What's more, a chemical stability and non-corrosiveness would be more perfect. Undeniably, a PCM should not be hazardous, highly inflammable or poisonous, and a reproductive crystallization without degradation would be wanted. Moreover, a PCM should be of abundant supply and at a low cost and have a small supercooling degree and high rate of crystal growth.

For instance, thermal compound storage material (CESM), made from inorganic salt and ceramic radical. Salt scatter in the porous structure of ceramic radical. Such material is very popular because of the high amount of heat produced and its stable output.

Polybasic alcohol compound and phase changing material is another relevant example. It is entitled to be the first option when referred to solid-solid transformation. Scientists mix (NPG) and (Mont) when melting, and such material interact with no factors surrounding in room temperature. Moreover, it can decrease the loss of heat. Hence, it is a promising, ideal material to make clothes by spinning and weaving.

Since liquid material are more likely to flow away, there is a necessity to apply MPCMs (Microencapsulation of Phase Change Materials) to the clothing. Just like capsule, the principle of it is to embed solid or liquid with hard shell. When the temperature reach the melting point of PCMs in clothing, its phase convert from solid into liquid, which produce transient refrigerating effect [6]. Thus, in the temperature outside under freezing point of PCMs, such molten material would be converted into solid and release heat to avoid the decrease of the body temperature [5].

3 EXPECTATION:

Such high technological fiber is entitled to be competitive in such highly developed clothing market and also bring a new, unique perspective to textile industry and the public. Three tendencies show as follows: first, it would be multifunctional and more complex to satisfy the consumers' increasing requirements about clothing properties, to be exact, fiber need to share more health-care functions like static-free, greasy dirt-free and antibiosis. Second, it must be environmental friendly in the future and noncorrosive, moreover, it would be better if it is a reproductive crystallization without degradation. Third, although Japan has researched such heat-produced fiber in twenty centuries, it was just applied in the clothing field last two years. Few researches pay attention on the study of this high technological fiber. Thus, we need to improve the properties of the products and meanwhile decrease the costs of that product at utmost.

Spinning products can bear a promising perspective in the future owing to the improvement of the high technology. However, faced with the such little researches concerning fiber and secrecy agreement with foreign countries, we are required to take charge more deep studies, especially the in-depth researches about fiber's moisture absorption , heat releasing, breathability and so on.

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