

Textile Structures Emitting Human Body Radiation

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ABSTRACT

It is well known that radiative transmission in a material can be expressed in terms of the scattering coefficients S and absorption coefficient K , which are related to the efficiency factors for forward scattering, transverse scattering, backscattering, and absorption.

Some textiles can effectively reflect longer-wavelength infrared radiation (from approximately 6 to 15 μm) (FIR) produced by the human body, but they have certain limitations. FIR textiles are designed to reflect back the thermal radiation emitted by the human body (maximum around 10 μm) back to its skin. Infrared (IR) radiation emitted by the human body is not the most efficient for localized heating of the human body. There is also a conflict between the optimal performance of radiant heating and comfort. FIR textiles are a category of functional textiles that have a presumed function for health and well-being. FIR affects the rotational and vibrational movements of molecules, which can be indicated, for example, by infrared spectroscopy. This alone is not sufficient to identify the intensity of thermal effects in the human-clothing system, but it is necessary to use devices that provide measurements of real temperatures.

Traditionally, aluminum foil, gold-plated, or silver-plated polymer layers are used as reflective layers in thermal clothing, which helps prevent the escape of thermal radiation into the environment. However, such an arrangement leads to problems with water vapor transport, which affects the wearer's comfort. The accumulation of water vapor at low ambient temperatures can lead to hypothermia. Sometimes perforated reflective foil solves this problem, but it results in large holes that compromise the thermal insulation properties. Therefore, it is a better solution to use only porous textile layers with a surface reflective layer.

This lecture presents current possibilities for creating thermal insulation textiles that reflect back (by the mechanism of direct reflection or back emission after absorption) infrared radiation in the wavelength range of 4–14 μm while maintaining sufficient breathability and eliminating or at least reducing the disadvantages of reflective foils and increasing the comfort of the garment for the user. The significance of FIR effects (the possibility of heating the body due to the effect of back reflection and emission of textiles) related to the heat emitted by the human body is also discussed. Models characterizing the radiation conductivity of porous textile structures made of fibers of various diameters and optical properties are described, which allow the selection of a suitable textile structure to support the use of reflection and retro-emission of radiation produced by the human body.

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