Janus-yarn based dual-mode fabric for radiative heat management

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Personal radiative heat regulation by photonic engineered textiles can help contribute to a more sustainable cooling and heating energy consumption in buildings by expanding the range of comfortable ambient conditions. Here, we propose a Janus-yarn structure for a dual-mode thermoregulating textile that provides both passive cooling and heating functions by flipping. Using metallic and dielectric fibers within the yarn creates a strong emissivity contrast, benefitting from a plasmonic gap on the one hand, and Fabry-Perot and multipole localized modes on the other hand. By tailoring the yarn structure, an emissivity contrast $\Delta \varepsilon = 0.72$ was achieved resulting in a significant 13.1°C setpoint temperature window, with the wearer staying comfortable between 11.3 and 24.4°C.

Heat loss

Convection
Moving air removes radiated heat

Radiation
Emittance of electromagnetic radiation

Conduction
Direct transfer by contact

Heat regulation

> 50% (1)

Thermal modelling

- Thermal comfort is defined as the equality between heat generation and total heat loss.
- By controlling the emissivity of the outer fabric surface, a different net radiative heat transfer can be achieved.
- For both modes, a thermal circuit model is used to calculate the ambient temperature that ensures comfort.

Thermal results

24.4°C
Comfort range

11.3°C

The textile user is comfortable between ambient temperatures of 11.3°C (heating mode) and 24.4°C (cooling mode).

Vast comfort range of 13.1°C.


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