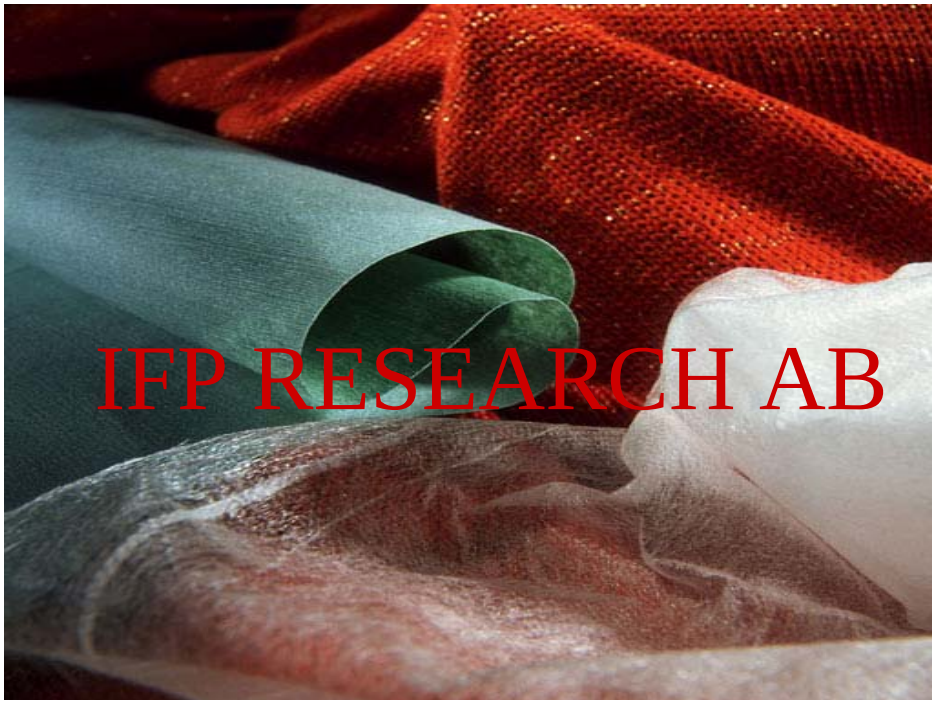


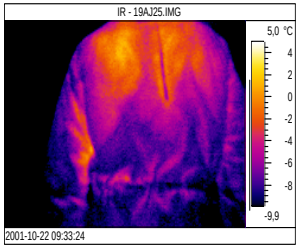
IFP Research
i korthet

- Forskning och utveckling (FoU) inom materialområdena fiber, textil, plast och gummi
- Erbjuder kunder:
  - FoU genom medlemsskapssystem och projekt
  - Uppdrag
  - Kurser, seminarier och konferenser
  - Tekniskspridning genom tidningar, föredrag, rapporter och artiklar
- 81 medlemsföretag inom olika FoU-program
- 1 500 uppdrag/ år
- Verksamhet i Mölndal och Borås
- 40 anställda
- SEK ca 40 miljoner i omsättning
- Ackreditering enligt SS-EN ISO/IEC 17025:2000

Strategiska forskningsområden

- Fiberspinning
  - Elektrospinning av nanofiber
  - Smältspinning

- Ytegenskaper hos formsprutade detaljer
- Komfort

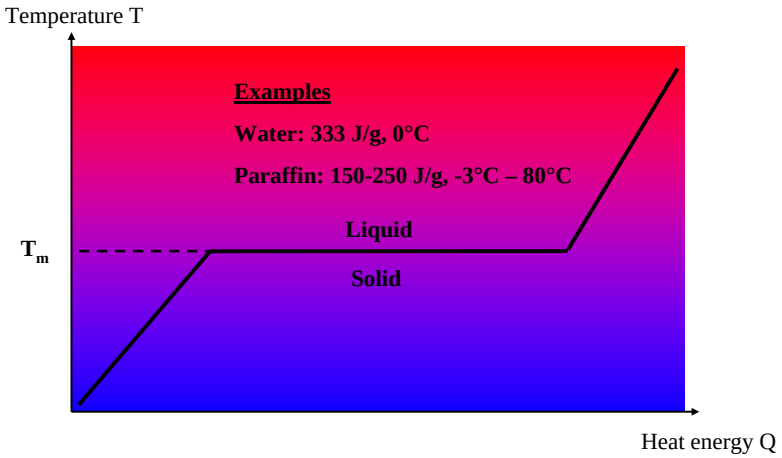


Phase Changing Materials (PCM) for Thermal Comfort

Bengt Hagström
IFP Research AB

IFP RESEARCH

High latent heat upon phase change (melting / crystallization)



PCM in cloths

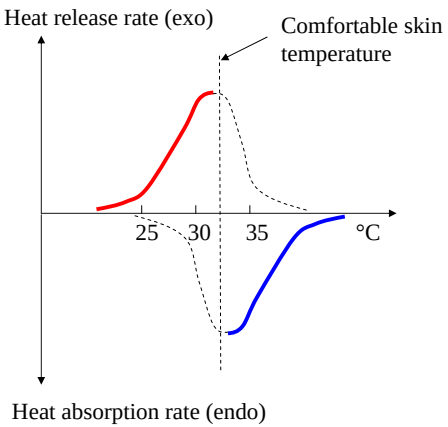
How it works

Ski booth with PCM

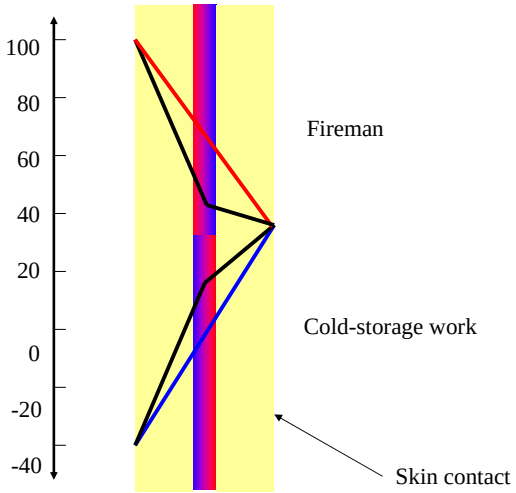
Hard work, PCM melts, energy is absorbed as latent heat

At rest, PCM solidifies, heat is given off

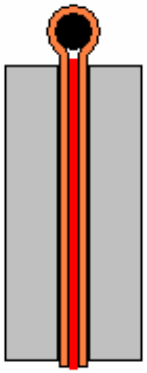
PCM in contact with the skin



PCM in intermediate layers



Measurements of temperature regulating properties of garments with PCM

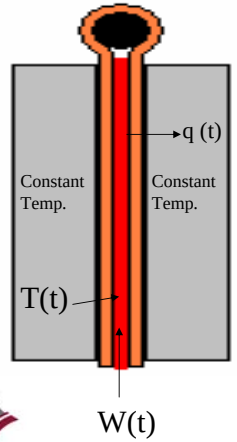


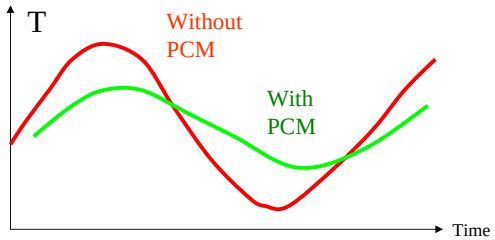
ASTM D7024-04

Temperature Regulating Factor (TRF)

ASTM D7024-04

$q(t) = 150 + 100 \sin(\omega t)$, W/m^2



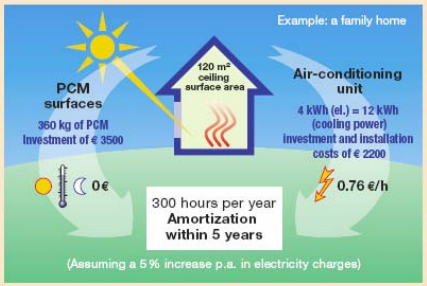


$TRF = (T_{max}-T_{min})/R(q_{max}-q_{min})$

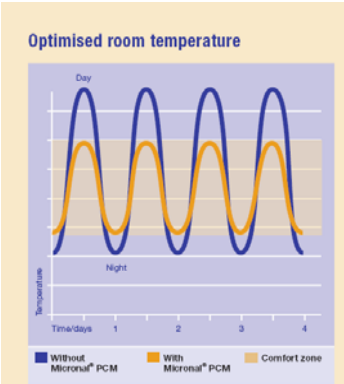
TRF = 1 No heat storage capability

TRF = 0 Infinite heat storage capability

PCM in buildings



Phase change materials reduce or eliminate the energy consumption of conventional air-conditioning solutions.



Active climate control: Phase changing materials reduce temperature peaks.

www.micronal.de

Examples of PCM-materials

- Hydrated inorganic salts
- Hydrated alcohols
- Polymers – polyethylene glycol (PEG), PEG/PET-co-polymers, aliphatic polyesters, Polytetramethylglycol (PTMG)
- Linear hydrocarbon waxes

Linear hydrocarbon waxes (paraffin)

C_nH_{2n+2}

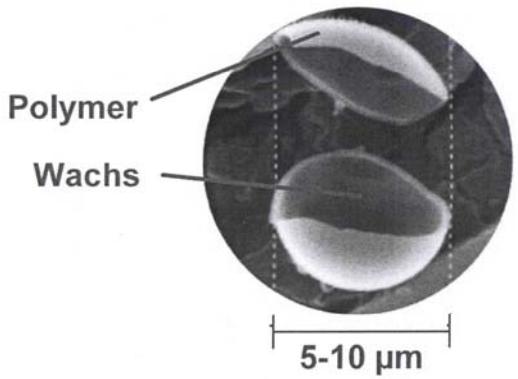
Phase Change Material	Number of carbon atoms (n)	Melting point (°C)	Heat of melting (J/g)	Crystallization point (°C)
n-hexadecane	16	16.7	237	16.2
n-heptadecane	17	21.7	171	21.5
n-octadecane	18	28.2	242	25.4
n-nonadecane	19	32.1		
n-eicosane	20	36.6	247	30.6
n-heneicosane	21	40.2	200	

Low price with high latent heats

IFP RESEARCH

PCM capsules

Micronal (BASF)



IFP RESEARCH

PCM-capsules

Thermasorb 83 (Outlast Technologies, 28°C)

Thermasorb 95 (Outlast Technologies, 35°C)

Lurapret® TX PMC 18 (BASF)

Lurapret® TX PMC 28* (BASF)

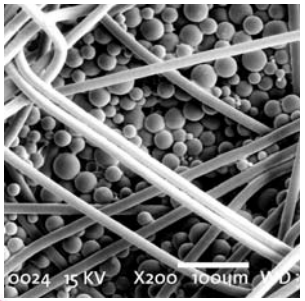
Encapsulence PC 140 (Ciba)

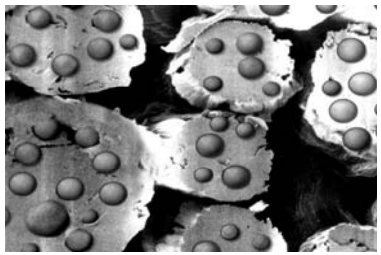
*180 J/g

IFP RESEARCH

PCM in fibrous materials

- Textile coatings containing PCM capsules
- Textile fibres containing PCM capsules

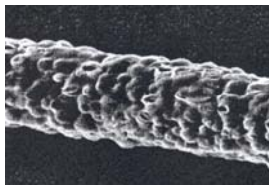


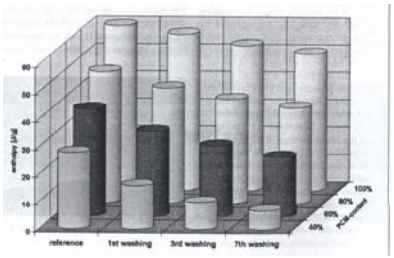


IFP RESEARCH

PCM-capsules so far only in wet spun fibres

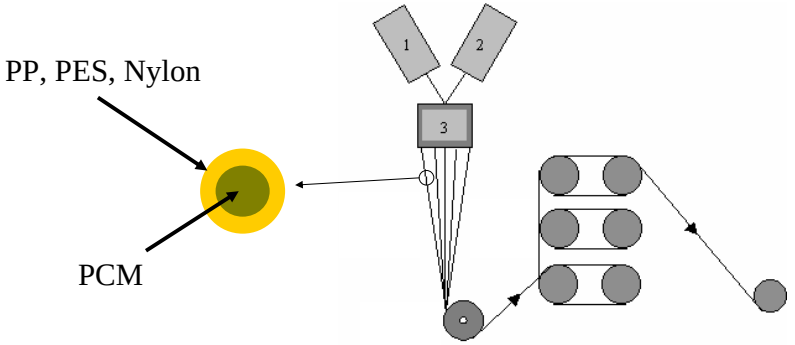
- Commercial PAN fibres with PCM capsules (Outlast®), low PCM-content (10%), 10 J/g
- PCM-capsules in Lyocell fibres has been demonstrated (Alceru®). Up to 60 J/g





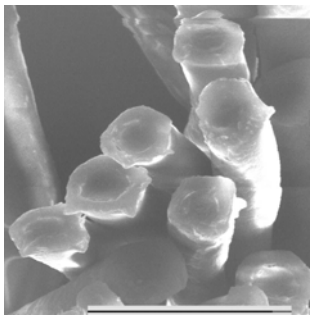
IFP RESEARCH

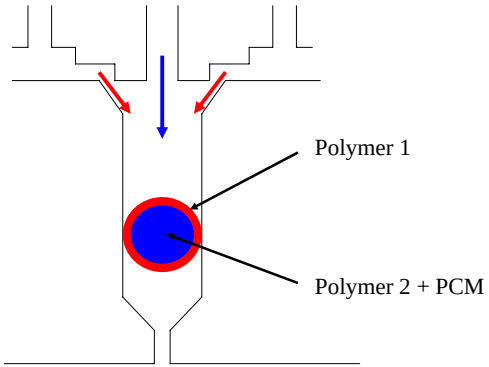
Melt spinning of bi-component sheath/core fibres with PCM in the core



IFP RESEARCH

Bi-component fibre with PCM



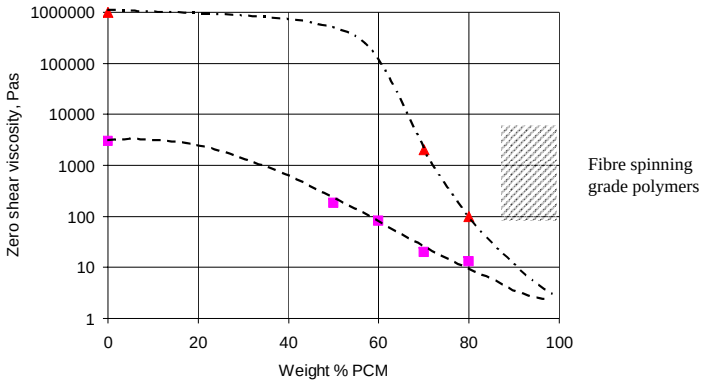


For process ability: $\eta_{core} \approx \eta_{sheath}$ (η = melt viscosity)

IFP RESEARCH

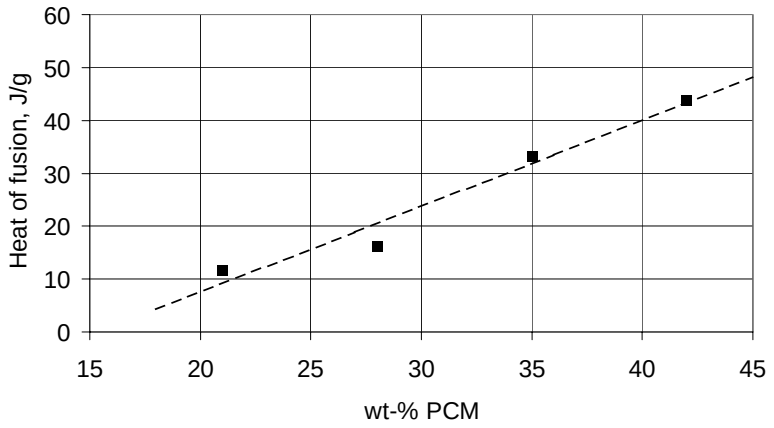
Viscosity of PCM/polymer blends

Two different thickeners

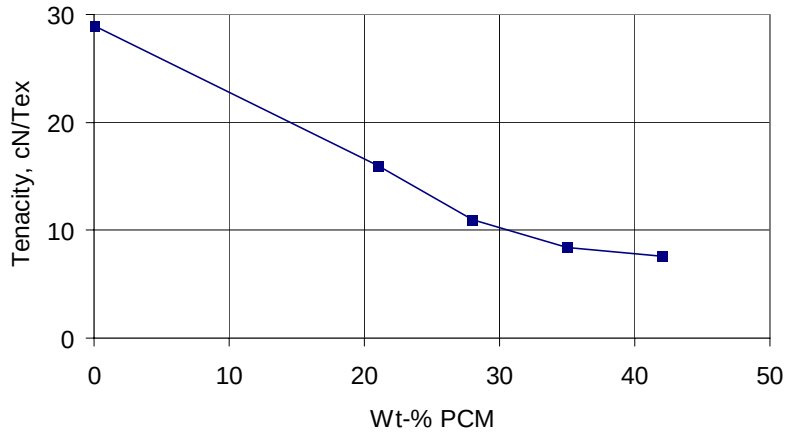


IFP RESEARCH

Latent heat in bi-component fibres



Fibre properties vs. PCM content



Challenges for further R&D

- High latent heat: > 50 J/g
- High strength: > 20 cN/Tex
- No migration (loss) of PCM
- No smell
- Low cost PCM and processing