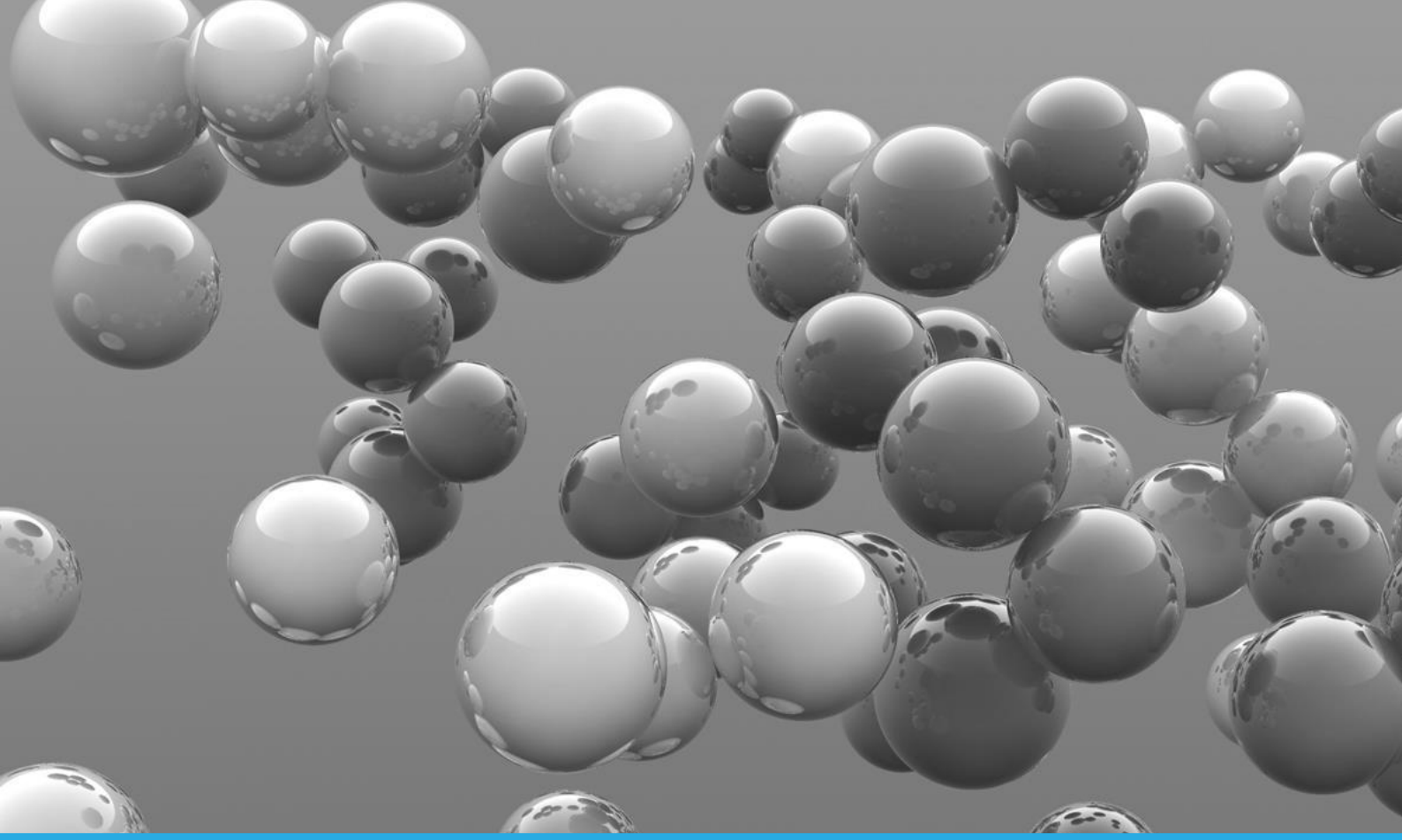
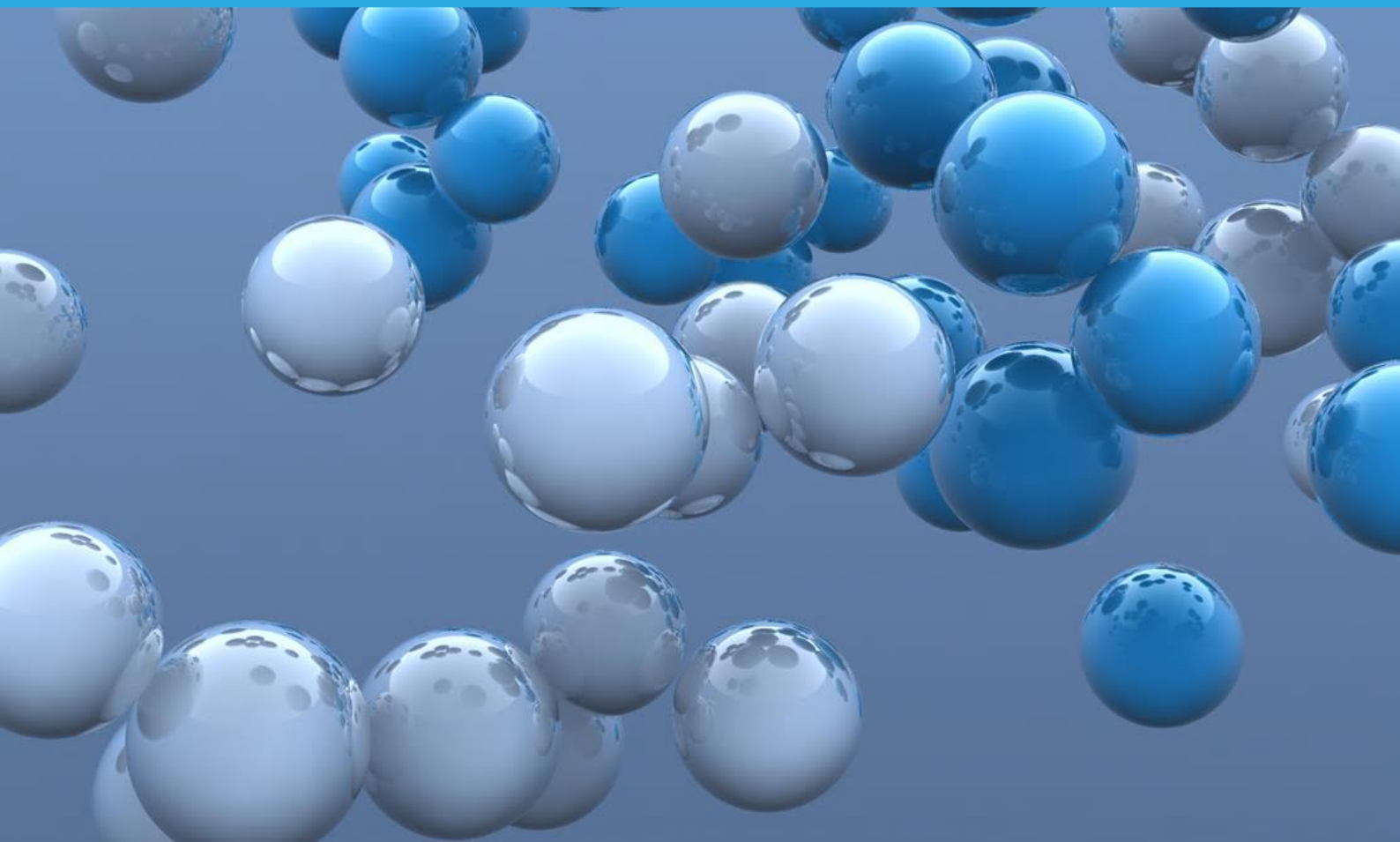


MICROENCAPSULATED PHASE CHANGE MATERIALS (PCMs)

by MikroCaps



Phase change materials (PCMs)

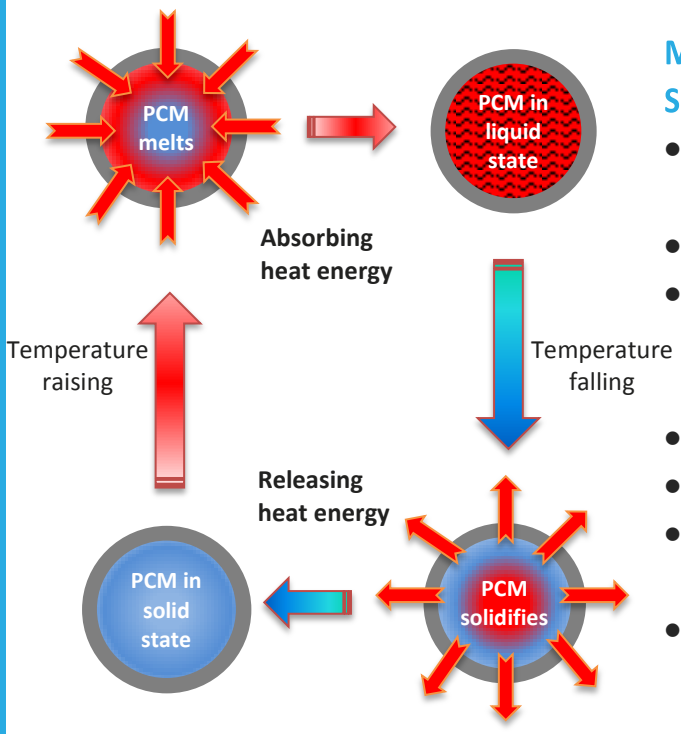
PCMs ARE 'LATENT' HEAT STORAGE MATERIALS

They are theoretically able to change state at nearly a constant temperature and therefore store a large quantity of energy.

The transfer of thermal energy occurs when a material changes from a solid to a liquid, or a liquid to a solid. This is called a change in state, or 'phase'.

SELECTING A PCM FOR A PARTICULAR APPLICATION

The operating temperature of the heating or cooling should be matched to the transition temperature of the PCM. The latent heat should be as high as possible, especially on a volumetric basis, to minimise the physical size of the heat store. High thermal conductivity enables the charging and discharging of the stored energy.



MICROENCAPSULATED PARAFFIN WAXES SEEMS TO BE THE MOST SUITABLE PCM

- a wide range of melting points (from 20 to 70 ^{O}C)
- high heat of fusion
- small temperature difference between the melting point and the solidification point
- harmless to the environment
- nontoxic
- stability for repetition of melting and solidification
- large thermal conductivity for effective heat transfer

Before applying PCMs, in most cases they have to be hermetically encapsulated in very small capsules to contain them while in a liquid state.
The diameter of such microcapsules ranges between 1 – 30 um.

MikroCaps Technology

MICROCAPS PCMs ARE SYNTHESISED VIA

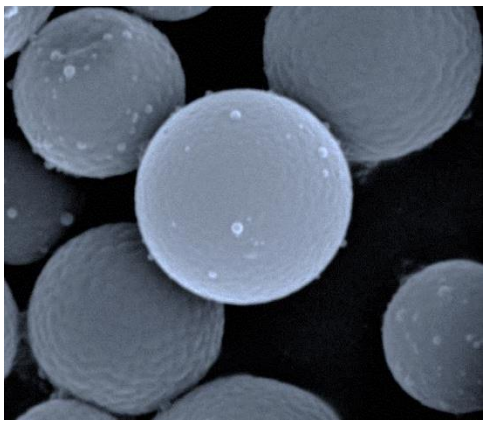
- **MELAMINE-FORMALDEHYDE (M-F), OR**
- **POLYURETHANE/POLYUREA (FORMALDEHYDE-FREE)**

AS A WALL MATERIAL.

In the development process, microcapsules are optimised by appropriate parameter settings:

- temperature;
- pH;
- mixing;
- concentration of reactants;
- emulsifiers; and
- modifying agent.

Flexible solutions for your business needs



SEM picture of MikroCaps PCM capsules

MIKROCAPS PCMs ARE RESISTANT

to mechanical action, heat and most types of chemicals.

Due to the small size of the microcapsules they are effectively used for many applications.

THE CHARACTERISTICS OF MIKROCAPS PCMs MAY BE ADJUSTED

to suit the customer's requirements:

- size of the microcapsules from 1 to 30 microns
- melting point (20 – 70°C)
- type of membrane (melamine formaldehyde or polyurethanic/polyurea)
- form
    - water-based dispersions (up to 40% of capsules)
    - powder

PCMs for buildings

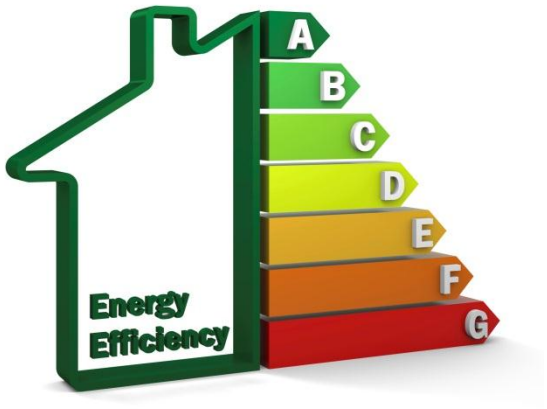
MICROENCAPSULATED PCMs ARE APPROPRIATE FOR VARIOUS APPLICATIONS

in buildings' wallboards, in underfloor heating systems and in ceiling boards.

The application of PCMs in buildings significantly reduces temperature oscillations and the energy consumption needed for cooling.

There are basically three different ways to use PCMs for heating and cooling buildings:

- PCMs in building walls;
- PCMs in building components other than walls; and
- PCMs in heat and cold storage units.



INCORPORATING PCMs INTO BUILDING MATERIALS

PCMs are incorporated into building materials as a dispersion or powder.

For all applications in which a liquid form is used, MikroCaps offers dispersions in which the microcapsules are dispersed in water.

For building applications which require a powder form (such as dry blends like plaster or cement mortar, for example), MikroCaps offers a powder form of microencapsulated PCM.

PCMs for bedding accessories and upholstered furniture

BEDDING ACCESSORIES

Microcapsules embedded into quilts, pillows and mattress covers ensure active temperature control in bed.

⇓ When the body temperature rises, the additional heat energy is absorbed and the body cools down.

⇑ When the body temperature drops, the stored energy is released and the body is kept warm.

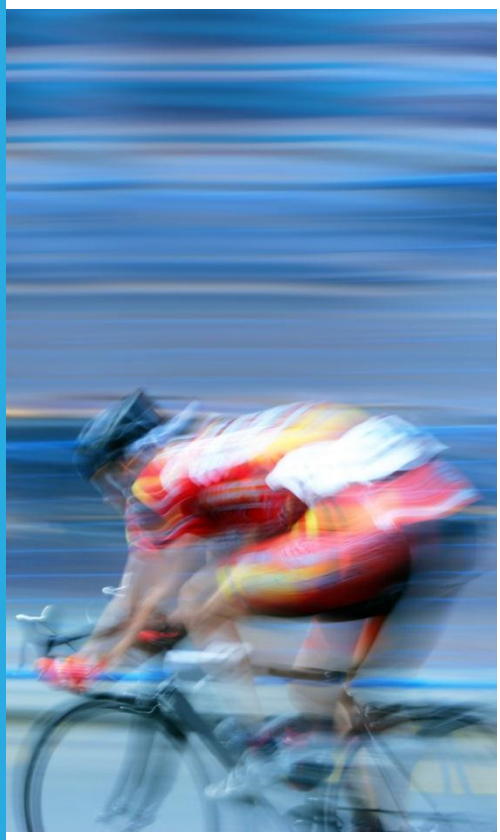
The incorporation of PCM in bedding accessories mainly proceeds by using foam techniques.

Microcapsules (dispersion or powder form) are mixed into a water-blown polyurethane foam which is applied to a fabric in a lamination process.
The water is taken out of the system by a drying process.

The honeycomb structure obtained while the foam is being formed creates a considerable possibility of trapping still air, thus allowing increased passive insulation.

UPHOLSTERED FURNITURE

Natural leather and fabrics are attractive materials for applications in the furniture industry.
Thermoregulating properties, as demanded by modern consumers, are added to the material.
Microencapsulated PCMs are incorporated into natural leather and fabrics using a polymer binder.

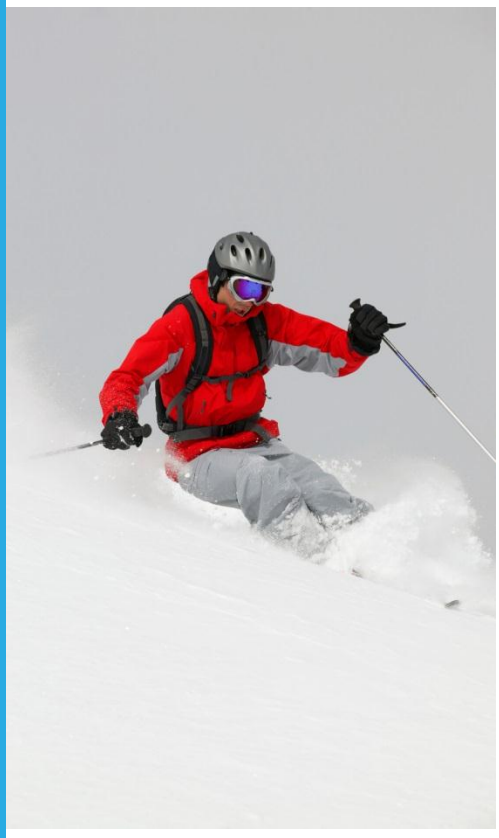


PCMs for sportswear

TEXTILES CONTAINING PCMs REACT IMMEDIATELY TO ENVIRONMENTAL OR BODY TEMPERATURE CHANGES.

Active wear provides a thermal balance between the heat generated by the body and the heat released into the environment while doing sports.

The heat generated by the body during sports activity is often not released into the environment in the necessary amount, thus increasing thermal stress.
When PCMs are incorporated into sportswear, during physical activity excessive body heat increases and is absorbed by the encapsulated PCMs and released when necessary.



THERMAL BENEFITS OF TEXTILES CONTAINING PCMs:

- a cooling effect, caused by the heat absorption of the PCM
- a heating effect, caused by the heat emission of the PCM
- a thermo-regulating effect, resulting from either the heat absorption or heat emission of the PCM which is used to keep the temperature of a surrounding substrate nearly constant
- an active thermal barrier effect, resulting from either the heat absorption or heat emission of the PCM which regulates, for instance, in a garment system the heat flux from the human body into the environment and adapts it to the thermal needs (i.e. activity level, ambient temperature)

The incorporation of PCMs into sportswear textiles

IMPREGNATION

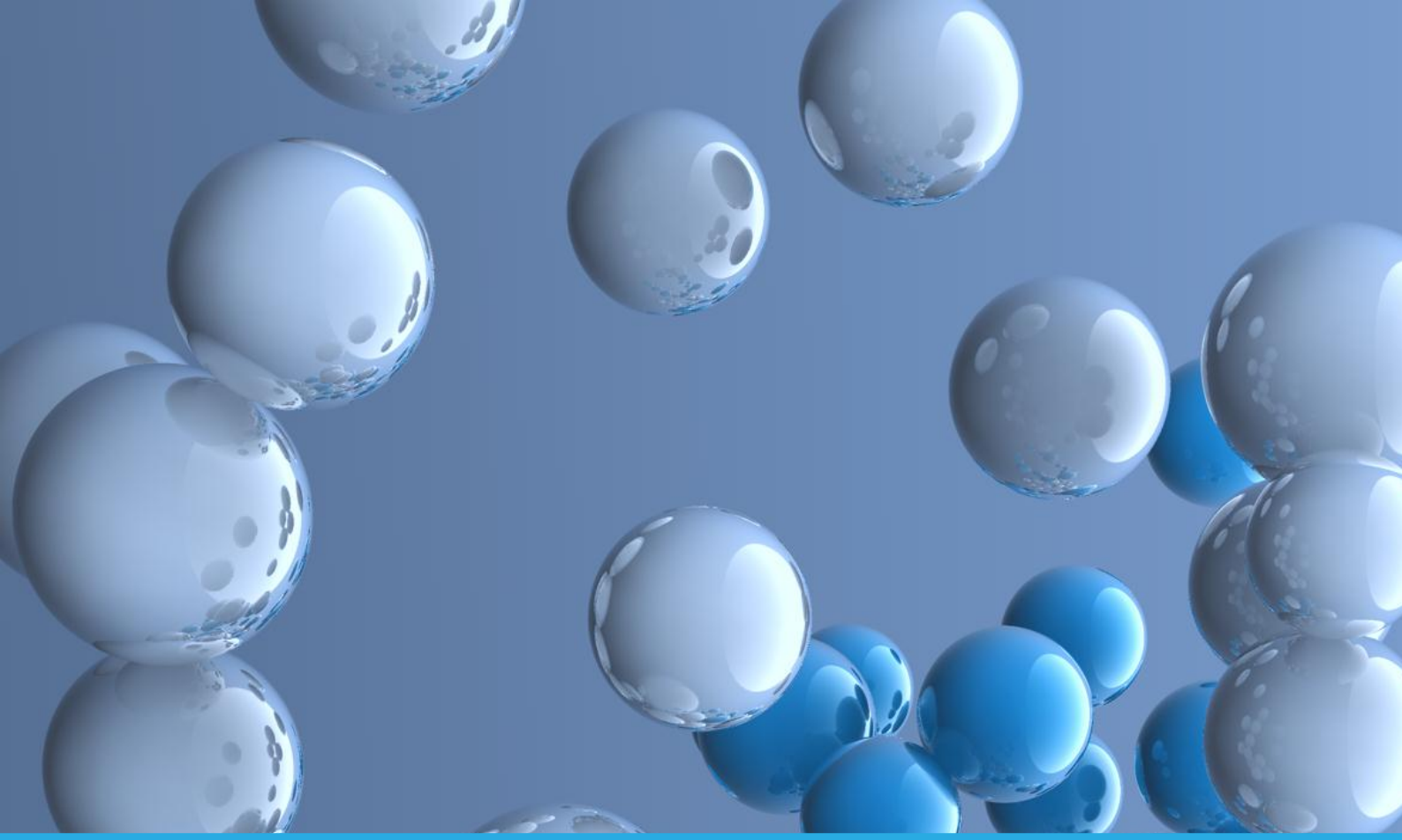
Microcapsules are mostly applied to textile by impregnation using a crosslinking agent followed by drying and curing steps.
Crosslinking agents fix the microcapsules, and keep them fixed during laundering.
Several kinds of fabrics can be impregnated with microcapsules, such as silk, cotton or synthetic fibres (polyamide or polyester).

INCORPORATION INTO FIBRE

MikroCaps PCMs can also be incorporated directly into fibres.
With this kind of incorporation a microencapsulated PCM (powder or dispersion) is added to the liquid polymer, polymer solution, or base material.
A fibre is then spun according to conventional methods such as dry or wet spinning and the extrusion of molten polymer.
MikroCaps encapsulated PCMs are resistant to mechanical action and high temperatures and thus appropriate for incorporation into fibre.

INCORPORATION INTO WINTER JACKETS AND GLOVES

For sportswear applications which require a powder form, MikroCaps offers a powder form of microencapsulated PCM.



MikroCaps

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