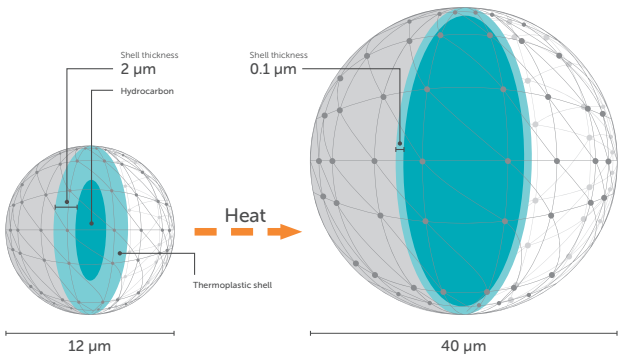
Expancel Microspheres in Technical Textiles

Expancel

Nouryon

Expancel Microspheres are small spherical plastic particles. The microspheres consist of a polymer shell encapsulating a gas. When heated, the internal pressure from the gas increases and the thermoplastic shell softens, resulting in a dramatic increase of the volume of the microspheres. The gas remains inside the spheres.



Expancel Microspheres in technical textiles

Expancel Microspheres can be used to enhance the properties of substrates. Different application techniques can be used, such as coating, laminating, spraying or impregnation. The characteristics of the microspheres give a number of interesting advantages. This leaflet will show you what and how.

Reduce costs by exchanging some of the binder and/or filler with the lightweight Expancel.

Improved product properties
Our microspheres can be expanded down to very low densities, they are compressible and elastic and the spherical shape gives good insulation properties. This gives the final product:

- increased bulk and thickness
- reduced weight
- improved compressibility and elasticity
- increased dimensional stability
- good insulation

The characteristics of the spheres also give **surface modifications** such as:

- matting
- improved hand
- anti-slip properties.

Depending on substrate, formulation and amount of Expancel, the extent of the effects may vary.

Content

Our microspheres

Expancel Microspheres are available in unexpanded and expanded forms, with different particle sizes and thermo-mechanical properties (e g start temperature of expansion, temperature resistance, density).

Expancel WU (Wet Unexpanded) is a wet powder with a solid content of 60 to 80 %, depending on grade. The water can be removed to create Expancel DU (Dry Unexpanded).

Expancel WE (Wet Expanded) are expanded microspheres with a solid content of approx 15 %. The expanded microspheres are also available as a dry powder, Expancel DE (Dry Expanded).

Recommended products for waterbased formulations:

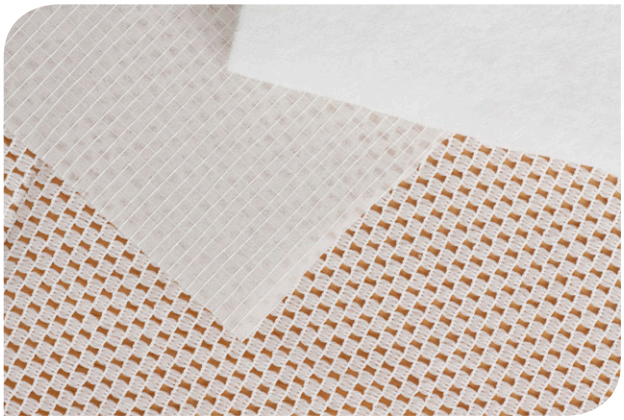
Product	Comments
551 WU 40	In-situ expansion.
053 WU 40	In-situ expansion. Good color stability.
007 WUF 40	In-situ expansion. Good color stability.
461 WE 40 d36	Low curing temp, smooth surface structure.

Recommended products for PVC plastisol formulations:

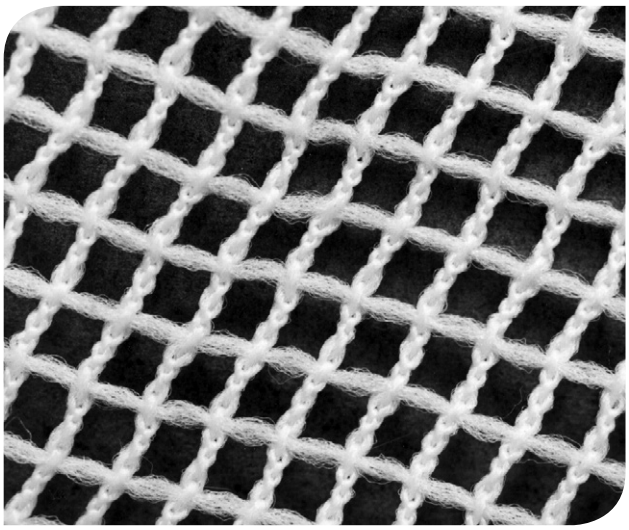
Product	Comments
051 DU 40	In-situ expansion.
909 DU 80	In-situ expansion.
551 DE 40 d42	Special requirements.
920 DE 40 d30	Special requirements.

Substrates

The appearance and material of the substrate depend very much on the type of technique for applying the compound and the type of end product. Picture 1 shows some substrates for insulation and underlay products. Picture 2 shows the fiber construction of a substrate mesh that yield good reinforcements and adhesion to the compound.



Picture 1. Examples of substrate.



Picture 2. Substrate mesh.

Application techniques

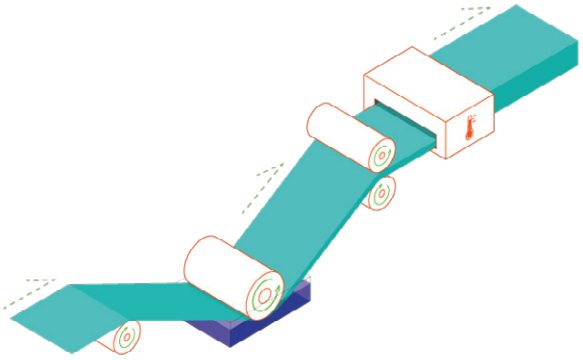
Impregnation

A traditional way of using Expancel in technical textile applications is to impregnate the substrate with a mixture of microspheres and a binder. To achieve good impregnation results, it is important that the substrate has a porous structure that allows the microspheres to get into the substrate matrix.

When you use Expancel WU and DU, it is also important that the fibers (or similar) of the substrate are not attached to each other by chemical bonds as this would prevent the expansion of the microspheres during the curing stage.

Process

The impregnation process is basically dipping a substrate into a compound and then heating it for curing and expansion. The expansion of the microspheres takes place during the curing process. This can be done by direct heating in a hot air oven or by IR-techniques (infra-red radiation).



The temperature of the drying/curing section and the time must be carefully adjusted in order to achieve the desired expansion.

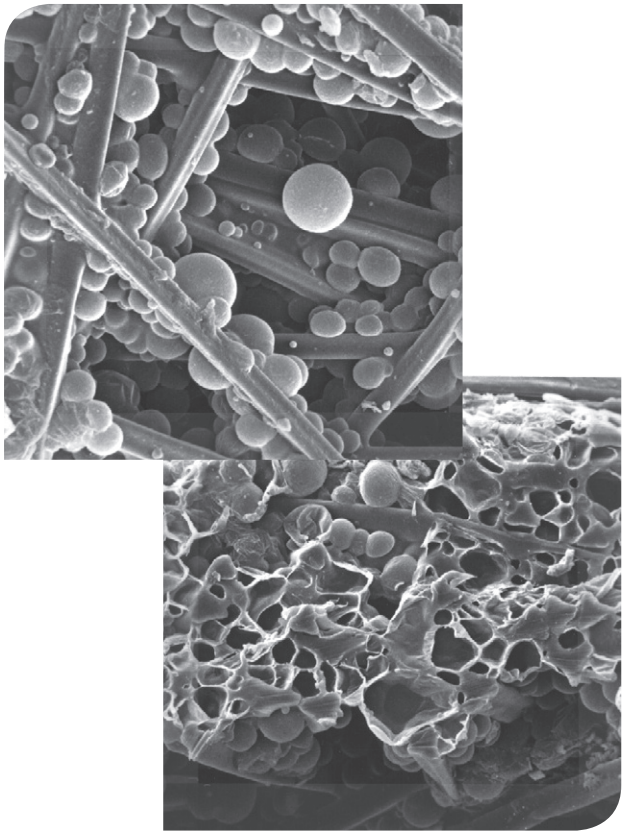
Some applications require a pre-drying stage at a lower temperature before the final curing in order to prevent voids in the matrix due to boiling effects of the solvent.

Examples of product structures

The appearance of the products depends to a large extent on the type of substrate, the formulation and the amount of Expancel. Picture 3 shows the expansion effect of Expancel in an impregnated nonwoven.

The SEM-photos (scanning electron microscope) in Picture 4 show the surface and cross-section of a substrate, impregnated with different types of binder formulations containing microspheres, after curing.

Picture 3. Photo of impregnated nonwoven before and after the expansion of Expancel.



Picture 4. SEM-photos showing the surface (left) and cross section (right) of a substrate impregnated with different binder formulations containing Expancel. (Magn 200x)

Coating

Expancel in a coating layer will

- add thickness
- improve surface characteristics and/or
- reduce weight.

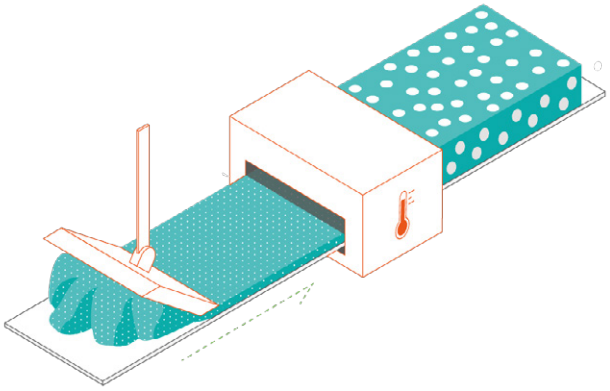
The cells formed by Expancel microspheres have a relatively narrow size distribution, which in turn provides a controlled uniform cell structure of the coating. The particle size of the microspheres influence the surface characteristics of the coatings, which means that it is important to choose the best suited Expancel grade. Small sized microspheres result in a smoother and more even surface structure, while larger microspheres give a rougher surface structure of the coating.

We recommend the expanded Expancel grades when you want a smooth surface structure on a substrate with a rough texture.

Process

One of the most common coating methods is the kiss roll application in different designs. The substrate passes over a roller partially immersed in a compound, or over a roller in contact with a transfer roller which is immersed in the compound. Another common method is knife coating with a doctor blade or floating knife.

After the coating step the substrate passes through a curing stage where the expansion of the microspheres takes place. The curing process can be done by direct heating in a hot air oven or by IR-techniques.



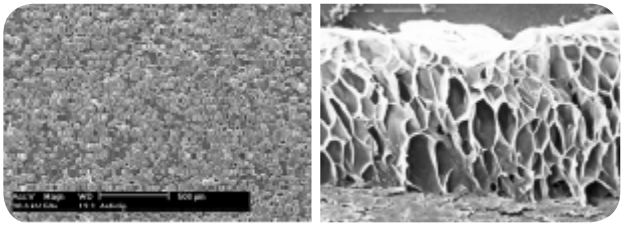
Carefully adjust the temperature of the curing section and the time in order to achieve good expansion of the microspheres. Variations of the temperature may affect the surface structure of the coatings and thereby weaken the product's reproducibility.

In order to prevent voids or blisters in waterborne coating due to boiling effects, it is preferable to have a pre-drying stage at a lower temperature before the final curing.

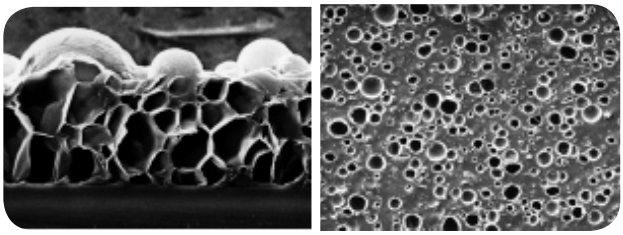
Examples of coating structures

The appearance of the products depends a great deal on type of substrate, coating thickness, formulation and amount of Expancel.

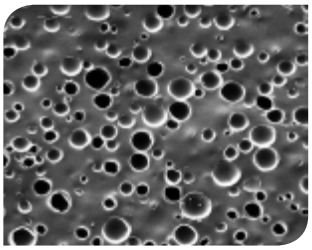
The SEM photos (scanning electron microscope) in Pictures 5, 6 and 7 show coatings after curing.



Picture 5.
Left: surface of a coating including Expancel. Magn 30x.
Right: cross section of a coating with in situ expanded Expancel. Magn. 140x.



Picture 6.
Left: cross section of a thin layer coating with in situ expanded Expancel. Magn 200x.
Right: cross section of non-aqueous resin coating with in situ expanded Expancel. Magn 60x.



Picture 7.
Cross section of non-aqueous resin coating with expanded Expancel. Magn 10x.

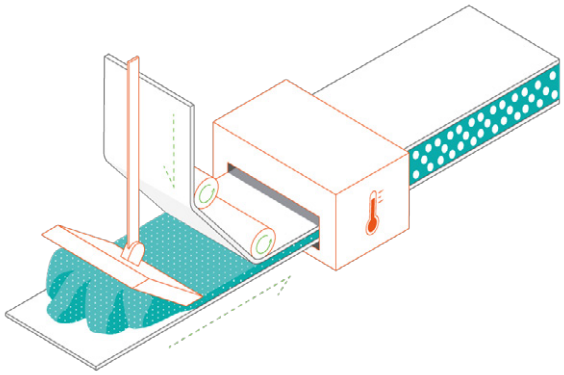
Laminating

Expancel microspheres in a core material generally improve the elasticity, compressibility and the insulation properties of laminates with textiles, paper or other technical textile substrates. The thickness of the core is basically controlled by the deposit and the amount of Expancel.

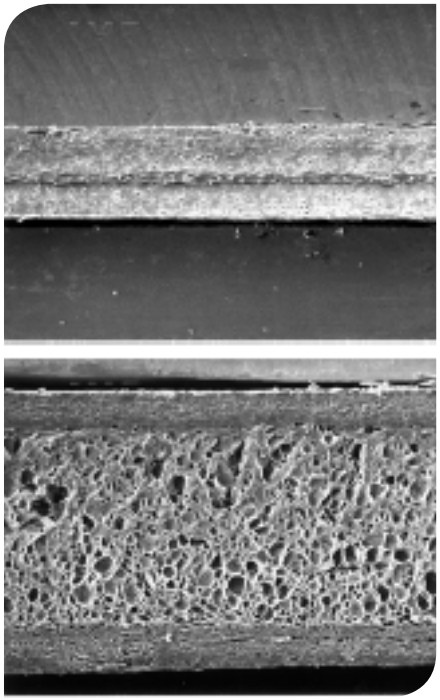
Depending on substrate, formulation and amount of Expancel, the extent of the modification differs.

Process

With an aqueous, or other volatile solvents, based formulation, it is preferable to pre-dry the laminate at lower temperature before the final expansion and curing. The formation of voids in the matrix is related to the boiling of the solvent.



Cross section photos of a laminated paper product



Picture 8. A laminate core with Expancel. Magn 30x.
Top picture, before expansion and curing.
Bottom picture, after expansion and curing.

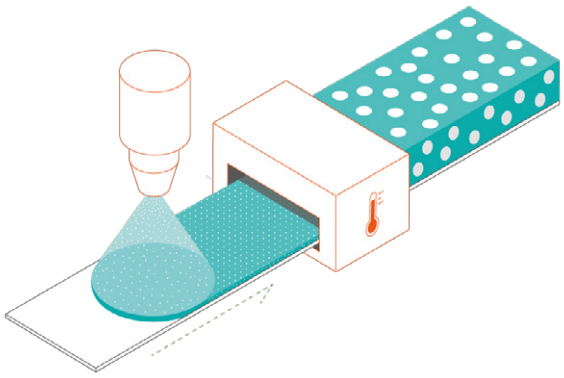
Spraying

An alternative way to apply a compound including Expancel into or on a substrate is by spraying. The resilient properties of Expancel make the spraying possible. The rheological properties of the formulation have to suit both the substrate (apply on or into) and the spraying process.

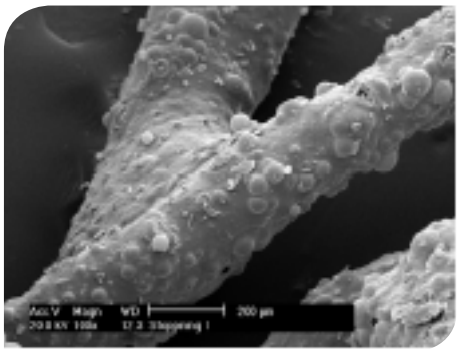
We recommend the expanded Expancel grades when you want a smooth surface structure on a substrate with a rough texture, or when it is necessary with a reduced curing temperature.

Process

There are a large number of spraying designs depending on the process requirements, e.g. type of substrate, amount of deposit etc.



Example of product



Picture 9. Expanded Expancel in a binder formulation applied with spraying on a fibre material. Magn. 90x.

Formulations

Expancel WU or WE are used in waterbased formulations while Expancel DU or DE are designed for non-aqueous formulations, e.g. PVC-plastisols.

Dosage

Unexpanded

The amount of unexpanded spheres (WU or DU) can vary from 0.5 to approximately 30 % by weight on solid basis, depending on the desired effect.

Expanded

The dosage of expanded spheres (WE or DE) is normally in the range of 0,1 to approx 4 % by weight on solid basis, depending on the desired effect.

At the lowest dosage, the change in hand and the matting are the only obvious effects. With higher dosages, the thickness of the product increases and a foamed structure appears.

The optimal addition of Expancel has to be tested out for each application as the formulations and the requirements differ.

Mixing

Proper dispersion of the microspheres is essential for the results.

Unexpanded

Expancel WU can be added to the binder as it is, if the binder system can withstand high shear forces (e.g. Silverson-mixer). Unexpanded microspheres are very resilient and are not sensitive to shear forces under normal conditions.

For binder systems that are sensitive to high shear mixing, such as natural rubber latex, we recommend that Expancel WU is added to the formulation as a 40 to 45 % slurry.

If inorganic fillers, like calcium carbonates or clays, are part of the formulation, WU and other fillers can be mixed simultaneously to form a slurry. The possible total solid content of the slurry then depends on the Expancel/filler ratio and should be tested for each application.

Care should be taken to ensure that the temperature of the slurry does not exceed 50°C (122°F) during the mixing as the microspheres may then start to expand.

The final mixing of binder, Expancel-slurry and other additives can be done with a conventional stirrer.

Expancel DU can be incorporated into the resin compound with conventional mixers.

Expanded

Expancel WE and DE are more sensitive to shear forces and should be added directly to the binder.

The expanded microspheres can be mixed into the binder with a conventional low shear mixer.

The rheological properties of the formulation are of vital importance to avoid microsphere flotation due to the low density of the expanded microspheres.

Binder systems

Expancel microspheres can be incorporated into a number of waterborne binder systems, such as natural rubber as well as synthetic latices and mixtures of the two. Expancel blends well with both full ammonia and low ammonia natural latices. The low ammonia type gives less odor during production.

When mixing synthetic latex with natural rubber latex it is essential that the former has a neutral to alkaline pH.

The choice of the synthetic latex is connected with the requirements of the application, such as hardness, flexibility, rub resistance, tensile strength, compressibility, washability etc.

In general, synthetic latices consisting of self cross-linking or cross linkable acrylic polymers, polyurethane or other acrylate based copolymers yield good properties.

There are also other polymer compositions that work well with Expancel.

In many cases the Expancel microspheres can be introduced into the user's existing formulation.

Thickeners

Expancel WU can be used in combination with acrylic and cellulosic thickeners as well as polyurethane and copolymer thickeners. When using Expancel 053 WU 40, due to the alkaline pH, pH-sensitive thickeners (e g cellulosic thickeners) must be added as a pre-thickened stock solution. If the pH of the formulation needs to be adjusted to give proper thickening this is easily done by adding for example ammonia. This is particularly essential when 551 WU 40 is used since it is slightly acidic in water and may decrease the pH of the formulation. The preferred thickener should be determined by the binder system used and the required rheological properties of the formulation for each specific application.

Fillers

Inorganic fillers, like chalk, talc etc, can be used together with Expancel. You must determine the maximum filler load in each individual case. The level of the filler content has an influence on the properties of the product, such as formulation cost, hardness, compressibility, flexibility, aging stability etc.

Accelerators, curing additives

Expancel microspheres are normally not affected by conventional accelerators and curing additives used for rubber curing, such as: sulphur, polysulphides, zinc oxides and zinc organic substances.

Crosslinkers

As for the crosslinking of synthetic latices we refer to the recommendation from the latex supplier.

In the case of in situ expansion of Expancel we do not recommend a too rapid curing cycle, as this will hamper the expansion of the microspheres. On the other hand, when using the expanded Expancel it is preferable to have a rapid curing cycle in order to minimize the temperature influence on the microspheres.

Preservatives

When cellulosic thickeners are used, a preservative is usually needed to prevent biodegradation of the thickener during storage of the formulation.

Drying, expansion and curing

Dry, expand and cure the substrate immediately after applying the compound, while it is still wet.

If the applied compound is dried before expansion it will produce a controlled uniform cell structure created by the expansion of the microspheres. If the compound is expanded without drying it will produce larger voids in the matrix due to the boiling of the water in the compound. The voids formed in this way causes an inhomogeneous appearance of the foamed layer, for example a rough coat surface.

The suitable temperature for drying depends on binder, grade of Expancel, weight of the deposit and type of substrate. In general, the temperature may be set between 30 to 100°C (86 to 212°F).

Expansion of the microspheres takes place during the curing process of the binder. This can be done by using contact heating, hot air, steam or IR-techniques.

The suitable temperature for curing depends on binder, grade of Expancel, weight of the deposit and substrate. In general, for WU or DU, the temperature may be set between 140 to 180°C (284 to 356°F).

You must adjust the temperature of the drying/curing section and the heating time carefully in order to achieve maximum expansion.

In the event of overheating and/or using a too long heating time the microspheres may collapse and become discolored.

Graph no 1 exemplifies the relation between the expansion properties of coatings and some polymer compositions of the waterborne binder. The expansion factor is expressed as the quotient of the expanded coat thickness divided by the unexpanded dry coat thickness.

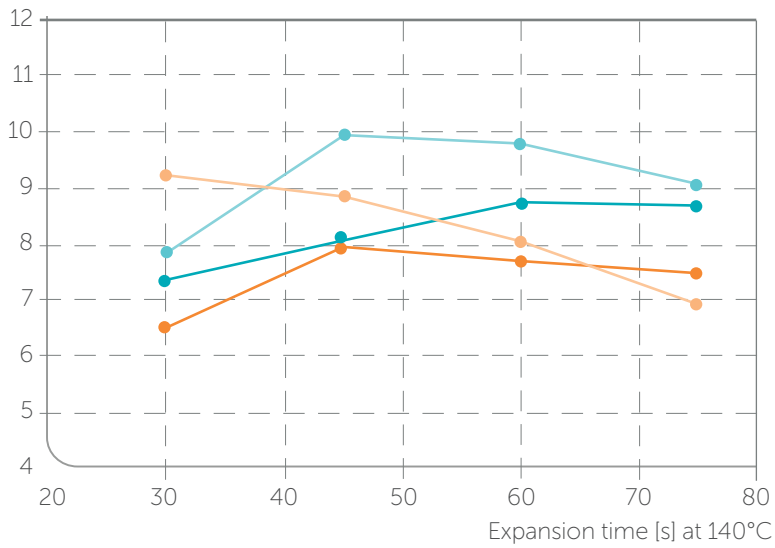
The expansion properties are also influenced by the curing rate of the polymers, meaning that other results can be obtained for the same polymers with different crosslinking properties.

Unexpanded coating thickness: 45 µm

Vinylacetate/acrylate copolymer
Mixture of acrylic polymer and vinyl-acetate/ethylene copolymer

Polyurethane polymer
Acrylic polymer

Graph 1: Expansion of coatings with 12 % Expancel 007 WUF 40 in different types of binders



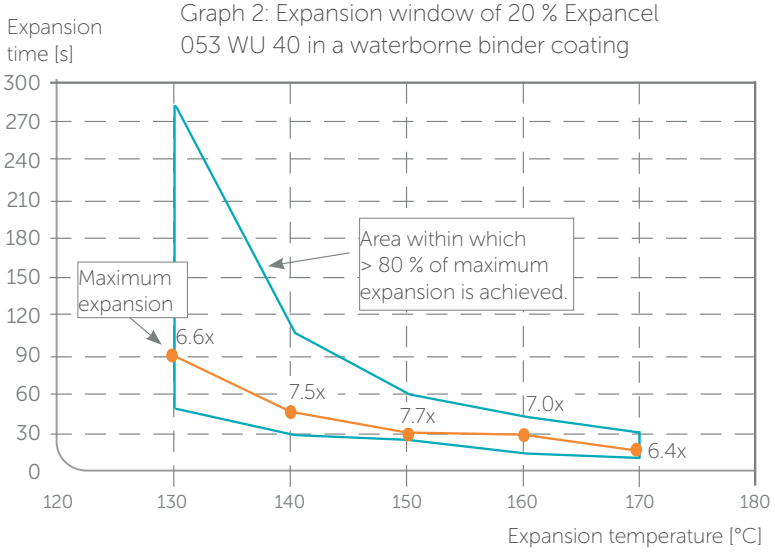
Graph no 2 exemplifies the relation between temperature and heating time for a specific coating formulation expanded in a hot air oven (Werner-Mathis oven).

The expansion properties are also influenced by deposit weight, amount and grade of Expancel WU.

Unexpanded thickness: 45 µm

Binder composition : Vinylacetate/ethylene and methylmethacrylat/ethylacrylat copolymers.

Graph 2: Expansion window of 20 % Expancel 053 WU 40 in a waterborne binder coating



Guiding formulations

The formulations below are based on laboratory tests only and you must check and adjust if necessary before adopting on large scale.
For colored applications you can add pigment dispersions to the formulations.

A. With natural rubber latex.

	Phr (solids)
Natural rubber latex	100
Expancel 053 WU 40	1 - 30 *
Thickener	To the desired viscosity
Vulcanization agent	As recommended with the latex used
Filler	0 - 100

* Depending on desired effect. Highest dosage without additional filler.

B. With synthetic latex.

	Phr (solids)
Synthetic latex	100
Expancel 053 WU 40	1 - 30 *
Thickener	To the desired viscosity
Crosslinker	As recommended by the latex supplier
Filler	0 - 100

* Depending on desired effect. Highest dosage without additional filler.

For certain applications additives such as pigment dispersion, defoamer, hygroscopic agent, light stabilizer, catalyst for cross linking etc can be part of the formulation.

In some cases the formulations in our application guide, "Expancel Microspheres in waterborne printing inks", can be used as a guideline.

C. With PVC-plastisol.

	Phr
Emulsion PVC homopolymer	100
Plasticizer (di-2-ethylhexyl phtalate)	50–70
Viscosity regulator	3
Heat stabilizer	
Expancel 909 DU 80	1 - 12 *

* For improved surface characteristics, e.g. matting effect, add 0,5 - 2 % Expancel 909 DU 80, using the coarser particle sized grade Expancel 920 DU 120 improves hand (softness).

The formulations in our application guide "Expancel Microspheres in Vinyl Foam" can be used as a guideline.

To find out more about our microspheres you can contact us at:

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Comments
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Expancel

Expancel® Microspheres is the world's favorite secret ingredient. You can find it in all your everyday essentials – your car, your shoes, the cork that protects your wine. It helps product developers worldwide expand their business, enabling them to reduce weight, cut costs, improve quality and create unique finishes. Expancel has dual functionality as a blowing agent and lightweight filler. The microspheres consist of a thermoplastic shell encapsulating a gas. Add heat and they expand dramatically, up to 60 times their original volume. The product is supported by unmatched technology know-how, ensuring smooth integration into any process. Expancel is a trademark within Nouryon – a world leading provider of expandable microspheres.

expancel.nouryon.com

Nouryon

We are a global specialty chemicals leader. Industries worldwide rely on our essential chemistry in the manufacture of everyday products such as paper, plastics, building materials, food, pharmaceuticals, and personal care items. Building on our nearly 400-year history, the dedication of our 10,000 employees, and our shared commitment to business growth, strong financial performance, safety, sustainability, and innovation, we have established a world class business and built strong partnerships with our customers. We operate in over 80 countries around the world and our portfolio of industry leading brands includes Eka, Dissolvine, Trigonox, and Berol.

nouryon.com

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