Calcium carbonates for microporous breathable films
Market and product requirements

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1-Historical View

From an historical point of view, microporous film, in its existing form, was developed in Japan in 1983 for the hygiene market and particularly for back sheet diaper films.
In opposition to the perforated or standard back sheet films the Japanese market was ready to accept films of higher quality despite the additional costs incurred.

Now, 12 years later the microporous films which had expanded first of all in the United States which developed later in Europe.
The microporous films quickly developed to become a large majority of the product lines in infant and adult health care.

As we can see further, the largest consumers manufacturing hygienic protection products offer on the market high quality products based on microporous films with a spreading quality and a well-proven comfort.

The use of mineral fillers in the fabrication process of breathable films has allowed a considerable development of these type of films, especially for hygienic films.
The mineral fillers and particularly calcium carbonate are in this special case active ingredients, giving the film special characteristics which allow it to breathe thanks to the network of micropores.

The explosion of patents on this activity area proves that it is still at the development and expansion level, even though it had started at the beginning of the 1980's.

2- CaCO3 as Raw Material

Omya, the world-wide leader of CaCO3, has committed itself to the partners of this channel, to develop a special product range of CaCO3 : OMYAFILM , which allows manufacturers to produce very exceptional films.

Thanks to the new qualities the horizon of these breathable films seems to be widening for the highest benefit for the end user.

For more than one century, Omya has produced CaCO3 for the paper, paints, lacquers and the plastics industry.
The know how, which incorporates an upstream and downstream knowledge of the business, allows Omya to be a special partner for the above mentioned different industries.

The plastic materials especially the Polyolefines build up a favoured target for this development.
The actual offer and support relies on more than 130 production plants, based upon a centralised operational organisation which leans on 5 labs on each side of the Atlantic.

For the plastics market Omya has developed a full range of fatty acid, coated and uncoated powder of :

- CaCO3

  Chalk
  Limestone
  Marble

- Dolomite

For the breathable film market we mainly use CaCO3, with a preference for Marble which brings a white aspect.

3- Breathable Film

The more common way to produce microporous films is to use a 43-52 % CaCO3 by weight polyolefin compound and to produce a stretch film which will present micropores in the structure.
The CaCO3 granules will play the role of void initiators during the manufacturing process.

In the microporous film the water vapour migrates through the film by following the conduit build thanks to the geometrical arrangement of the CaCO3 particles, as well as the film providing a barrier to liquids.

In contrast, we find monolithical films with homogenate structure, which adsorbs the water vapour. This vapour will then be diffused through the polymer and afterwards evaporated on the other side of the H_2O saturated medium. The very well-known monolithical films consist of polyester films or films based on PVOH.

The WVTR (Water Vapour Transmission Ratio) will be improved by playing on the thickness of the film, or i.e. on the composition of the polymers. This final solution is quite obviously more costly than the microporous films.

4-Microporous Films Conception

Microporous films can be manufactured either by casting or blowing, followed by stretching on- or off-line.
To achieve the final result, we must disperse uniformly in a polyolefin matrix a special CaCO3 to optimise the films properties.

The 3 following phases play an important role :

Compounding and receipt
Extrusion
Stretching

Some criteria has to be respected to reach the final result :

Compounding Criteria

- To disperse uniformly 50-70 % of $CaCO_3$ in a Polyolefin Matrix
- To produce a batch with a very low moisture content.
- Not to destroy the CaCO3 (surface treatment) and Polyolefines chains

Extrusion Criteria

- To produce a film without " fish eyes" or " lensing" with a dry compound.

Stretching Criteria

- To produce a thin film (25 µ or below) at a high speed rate.
- To stretch a film in 1 or 2 directions to create uniform micro-holes on the surface
- To create a good pore size structure and distribution

When all these conditions are respected, we can achieve a film containing a close mixture between the filler and the matrix.

The creation of the final product could be modified by combining with a non woven.
The breathable film could be laminated with this non woven which will provide a cloth-like product with good strength characteristics.
This laminated product could be made by extrusion lamination with adhesive bonding or thermal bonding.
In the assembly of the garments (final product) , the seams are formed by ultrasonic or thermal welding which may require an appropriate selection of the Polyolefines used to provide adequate seals between the film and the non woven layer.

5-Films Requirements for the Different Applications

The microporous films have two main outlets :

The hygiene application with diapers films for infants, sanitary napkins or adult incontinence.

Construction application for house wraps, wall covering and under-tile roofing films.

However, other areas use the characteristics of these films particularly in the medical sector for example, disposable clothing.

The variety of these applications lead to different requirements.

5-1 WVTR :

For the hygienic sector, the WVTR which is measured at the temperature of the skin (38°C/90% humidity) can vary between 5000 – 15000 g/m^2/day according to the ASTM E 96 B standard.

This WVTR could be adjusted by controlling :

- The structure of the polymers of the matrix
- The stretching ratio applied on the film
- The filler content of CaCO3
- The choice of CaCO3

For adult garments and due to the larger surface area, the WVTR value for these products could be lower with an average value between 5000-6000 (g/m2/day).
For the construction sector , the measuring temperature is 23°C and the humidity 85 % (ASTM E 96 D).
The WVTR could also be different depending upon the final application e.g. wall covering or roofing films.

5-2 Mechanical Properties :

Depending upon the application, the tensile strength elongation and tear strength values are predefined for the non laminated films.
For a constant thickness of film, the choice of the resin but especially the CaCO3 choice is fundamental in deciding the final values.

However the variation of the thickness remains the most reliable solution to attend the final result. Thus for the baby diapers they work with films of 12 to 25 µ whereas for the adult incontinence products they use films which are 2 times thicker. Also for the construction industry the thickness is approximately 50 µ.

5-3 UV- and Chemical Resistance :

Good acid, alkali and UV resistance is usually required for film used in the construction industry. Selecting the right polyolefin and the appropriate $CaCO_3$ ensure these properties. Also there is often demand for a flame retardant film.

5-4 Water Pressure : (Hydrostatic Pressure Test)

As the film is also functioning as a barrier to liquids, the resistance to water pressure is a factor which has to be taken into consideration.

For the hygiene field, the films require a resistance value of approx. 1,2 kg/cm^2 whereas for the building industry they need 1.6 kg/cm^2.

The water pressure (P) of a microporous breathable film could be directly related to the pore radius and the contact angle according to Laplace :

$$P = - \frac{2 * \gamma H_20 * \cos. (\gamma H_20 , \gamma v)}{r}$$

where γH_20 is the surface tension of the water, r the radius of the pore and $(\gamma H_20 , \gamma v)$ the angle of contact between the surface and the water droplet.

This angle will increase by improving the surface coating of the $CaCO_3$ and in this way, the value of P is increased.

The most important role will be played by the radius. The smaller it is, the higher is the hydraulic water pressure that can be reached, but at the same time, the WVTR will decrease.

6 - Caco3 Requirements

To fulfil the films requirements of which CaCO3 is playing the most important role, the choice of CaCO3 is very determinant.

This CaCO3 will influence :

The visual aspect
The colour
The WVTR (Water Vapour Transmission Rate)
The mechanical properties

WVTR is the main value to evaluate a breathable film. This measurement is currently made under ASTM E 96

6-1 **Hydrophobicity**

Hydrophobicity is useful to avoid moisture and moisture pick up during the compounding, storage, transport and extrusion process.

6-2 **Granulometry Repartition**

A steep curve of granulometry with a defined main size for the particles (1 to 2µ) is required. The finest particles will affect the compounding process by generating a too high specific surface area which would affect the share ratio and also the output rate in the compounding process.
The coarser ones destabilise the micropore structure and affects the mechanical properties of the film.

6-3 **Thermal Stability**

$CaCO_3$ has to show a good thermal stability to support first a compounding phase with temperature up to 280-300 ° C and then a second thermal choke sometimes up to 300 °C during the extrusion process.

6-4 **Whiteness and Hiding Power**

$CaCO_3$ must bring a white and uniformed surface without having to add TiO_2.

6-5 **Dispersability**

Intrinsically linked up with the desire to have a totally dispersed $CaCO_3$ in the matrix without agglomerates during the compounding process.

7 - OMYA Offer

Thanks to its expertise in the plastics market, Omya has developed a special range of $CaCO_3$ to fulfil all these requirements.

The **OMYAFILM** range allows all breathable film possibilities from the most simple to the most demanding.

Special surface treatment	Hydrophobicity Dispersion Thermal stability
Steep curve	Less coarser particle Small amount of fines
Marble base	Whiteness Opacity
Special grinding system	Adequate shape

OMYAFILM : The Answer for Breathability

8 - Market Overview

Only focused on the hygiene and building sectors this year should consume a total world-wide tonnage of films amounting to approx. 500.000 tons and this for all mixed qualities. (standard film and microporous).

The average market growth is estimated at 5 % for building application and approx. 3% for the hygienic activities.

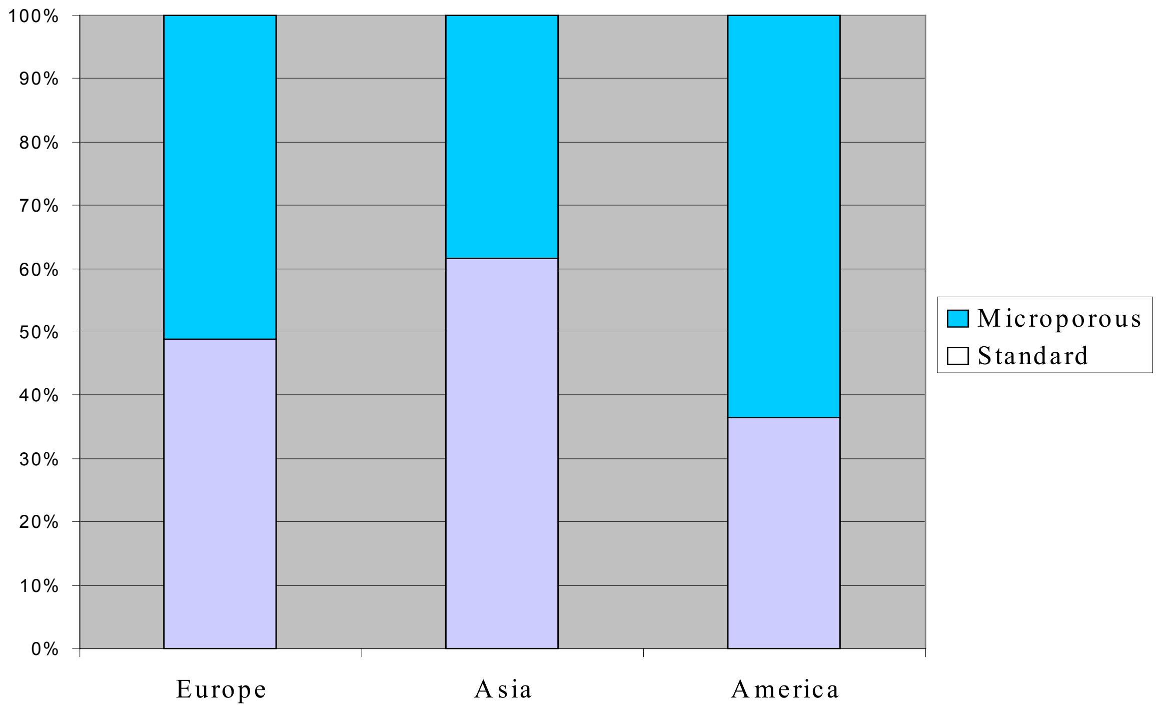
Dealing with microporous film the progress is very disparate from one region to another because of the industrialisation level and the coverage of the market.
In this way we note that in Europe there is a very strong progression in the building market which is in comparison to the already well-established American market.

If we differentiate between the two film markets, the hygienic sector should represent in 2005 approx. 450.000 tons and the building industry approx. 150.000 tons.

The development of microporous films is immediately linked up to the geographical region and the historical introduction of this new technology.

In 2001 the replacement level of the traditional films in the hygienic sector through microporous films amounts to 53 % in Europe, but this figure is only 38 % in Asia, even though in the USA it is already 51 %.

Diapers back sheet film : Breakdown per Geographical Area in 2001



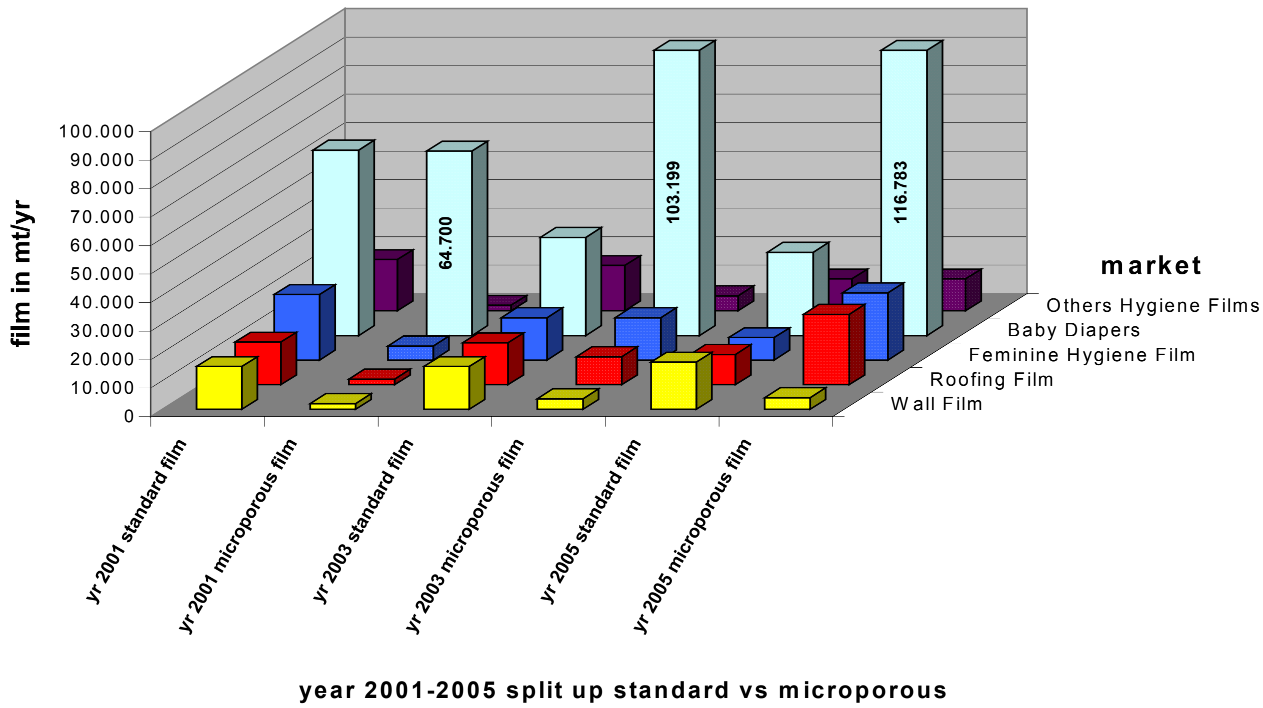
8-1 European Overview

Europe, which has seen a late introduction to the microporous films presents an interesting configuration : in fact the tonnage of microporous films should be trebled in 5 years and the amount of all mixed quantities should reach 150.000 tons of films per year in 2005.

The diapers market already amounts to 50% for the microporous films, which should reach within 5 years more than 80% of this market and should be saturated in 2008.

The incontinence market for adults and the female care sector could represent an important capacity, because of the fast growth of these products.

The building market should represent in 2005 the most rapid growth of about 30.000 tons of microporous films.



8-2 World-wide Overview

As we plan for the next five years and we are looking on the global market, (Cf. graph) the following remarks are essential :

The growth of the microporous films market is essentially derived from infant diapers.

Female care as well as adult incontinence should be mainly represented by microporous film.

The actual shape is, without allowing for any merging markets, the global tonnage of microporous films should amount in 5 years to approx. 400.000 tons, even though today it is only 175.000 tons.

9 - New Possible Field of Application

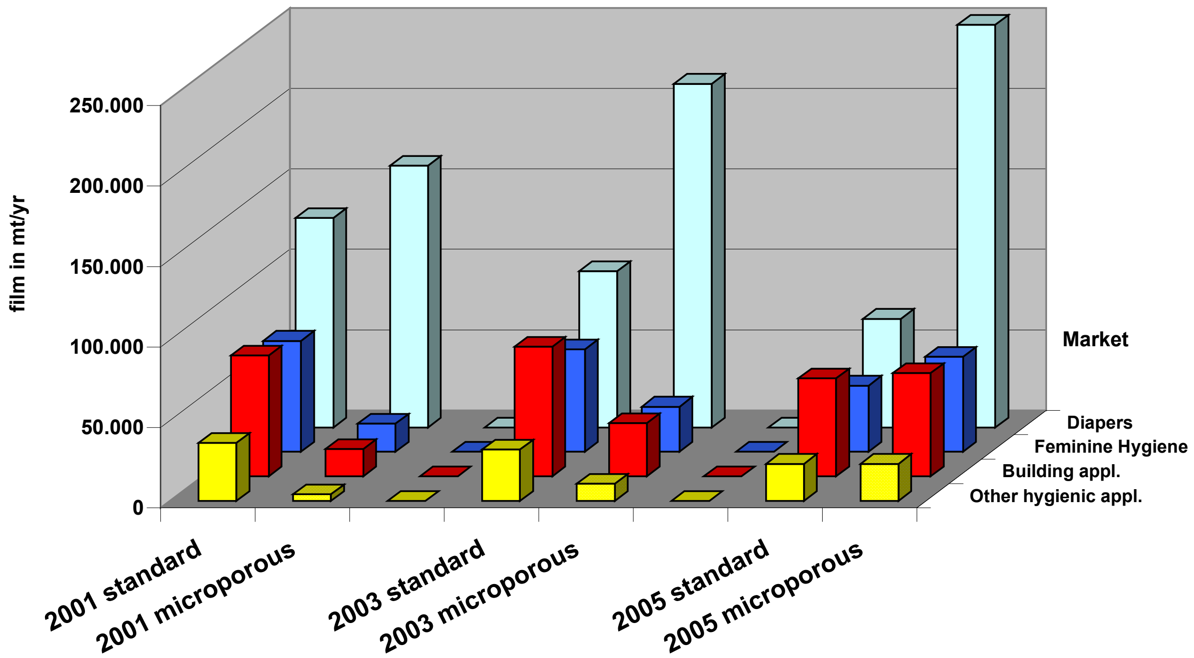
The interesting properties of these films, linked up with a development of the high speed production lines (250 m/min), will make the product more attractive, allowing the market to consider some application diversification.

The packaging sector should certainly use the possibility of the transfer of appropriate water or gas vapour for fresh food packaging.
This food which needs to respire can be packed in unit and thanks to this film the freshness will be kept.

Another outlet of these films could be considered in the agriculture sector. For example in greenhouses films have to avoid the phenomena of condensation which causes drop falls which damage plants.

In the medical field operating garments are already made with such kind of films but their use could be intensified as the perspiration can be evacuated bringing a supplementary comfort. Some other similar applications like bed sheets or drapes are also possible.

More generally the substitution of textile composites in the garment industry, which offer more or less the same type of benefit (breathable water barrier), could be the most important source of development in the near future.



Standard vs microporous film usage

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