



## Technical Information

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Improved properties of polyethylene films  
by using high-performance fillers

*Hidden inside – Performance outside!*

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## ABSTRACT

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Additives on a mineral raw material basis are highly suitable for influencing the various desired properties of plastic films. In the present studies we concentrated on the following films and their requirements:

- Packaging films with anti-blocking properties and good optical properties
- Agricultural films with high requirements of high UV transmission and IR absorption

The additives used in this technical information are characterised by very good optical properties and a refractive index that is almost identical to that of the polyethylene films used.

Different particle size distributions play an important role, especially with anti-block films. The additives used in this technical information are available in these different particle size distributions, so that different additives of the same mineralogy can be selected depending on the film thickness. This ensures that the films can be easily "detached" from each other or from other materials. Since customers often want to see what they are buying, not only the mechanical properties but also the optical properties such as transparency or haze play a role. However, these are easier to achieve due to the low filling levels than with agricultural films with high filling levels.

In contrast, the optical properties of the additives play a particularly important role in agricultural films with higher fill levels. The addition of our additives has only an insignificant effect on the overall light throughput. In addition, our additives cause a wider and more uniform light scattering. Furthermore, the addition of our additives reduces heat emission from the greenhouse. This ensures a healthy growth of the plants in greenhouses.



## INTRODUCTION

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In the field of thermoplastics, our mineral additives give polymers partly outstanding properties in terms of mechanical strength and thermal properties (HDT, shrinkage).

Whether as packaging for food, in vehicle construction, in medical technology, in construction for thermal insulation or in agriculture. Films are used in a variety of applications and must meet the corresponding requirements. More and more packaging that can do more is in demand. Films that not only pack, but are easy to open, keep fresh longer and can be resealed.

When films are used to package fruit, vegetables, fish, sausage or cheese, anti-blocking agents are used as "spacers" to separate the film sides more easily. The effectiveness of the anti-blocking additive depends mainly on the properties of the mineral used and the correct grain size. In addition to the mechanical properties, optical requirements such as transparency, gloss or opacity are often added. Consumers want to see the contents of their purchases and are therefore particularly interested in transparent plastic packaging.

Greenhouses made of plastic film offer a cost-effective solution to intensify agriculture. This is becoming increasingly necessary due to growing cities and shrinking farmland. When using films in agriculture, the focus is on requirements such as UV and IR absorption. The sun's rays should easily penetrate the agricultural film in order to stimulate plant growth. However, the heat should not escape again during the night, but should be stored in the greenhouse to compensate for temperature differences and ensure an even temperature for healthy plant growth.

## TESTED ADDITIVES

Our additives with very good optical properties, whose refractive index is close to that of polyethylene, are particularly suitable for use in polyethylene films.

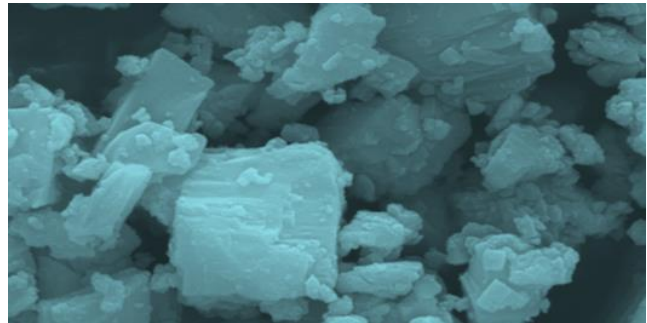
### Anhydrite

TREFIL® 1313-400  
TREFIL® 1313-600

The finely ground and processed natural anhydrite belongs to the anhydrous sulphates. It is often formed as an evaporation product of seawater and with progressive concentration of the salt water solution. Anhydrite forms the stable soil body of gypsum deposits and can be mined separately.

Formula:  $\text{CaSO}_4$

- tabular structure
- density of  $3.0 \text{ g/cm}^3$
- hardness of 3.5 (Mohs)
- high whiteness ( $Y = 89$ )
- good transparency



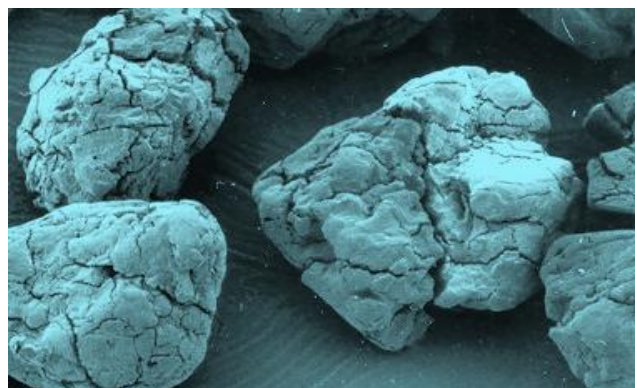
### Cristobalite

SIKRON® SF 4000

Since cristobalite only occurs very rarely in nature, it is synthetically produced for industrial purposes from pure silica at approx.  $1,500 \text{ °C}$  in a rotary kiln. The lattice structure is widened, which reduces the density and results in a high degree of whiteness. Like silica, cristobalite is chemically inert.

Formula:  $\text{SiO}_2$

- blocky structure
- density of  $2.35 \text{ g/cm}^3$
- hardness of 6.5 (Mohs)
- high whiteness ( $Y > 94$ )
- high chemical resistance
- coefficient of thermal expansion:  
 $54 \cdot 10^{-6} / \text{K}$  (at  $T 20 - 300 \text{ °C}$ )



## Feldspar

MICROSPAR® 1380-600	MICROSPAR® 1379-300	MICROSPAR® 1379-350
	MICROSPAR® 1379-400	MICROSPAR® 1379-600

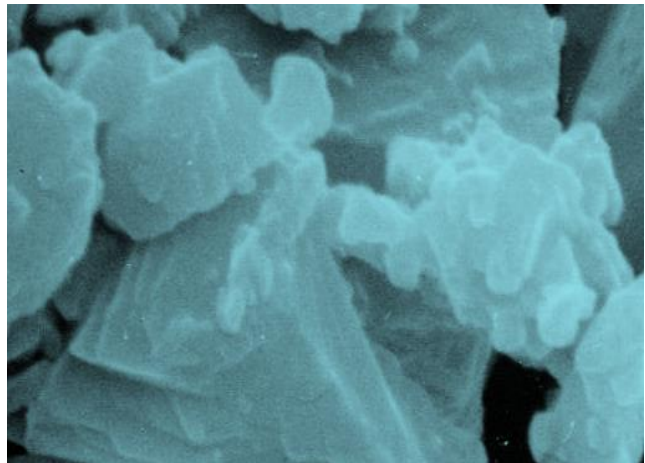
With a participation of almost 60 % by weight in the construction of the earth's crust accessible to us, the feldspars are by far the most frequent mineral group. Feldspar is a chemically resistant tectosilicate with a thick, platelike grain morphology. In our production plants, mainly potash feldspar is processed and separated, classified and finely ground using complex processing technology.

Formula:

MICROSPAR® 1380 =  $\text{KAlSi}_3\text{O}_8$

MICROSPAR® 1379 =  $\text{NaAlSi}_3\text{O}_8$

- thick tabular structure
- density of 2.6 g/cm<sup>3</sup>
- hardness of 6 (Mohs)
- high whiteness (Y > 90)
- high chemical resistance
- low refractive index
- behaves transparently in many binder systems



## Overview of the tested additives

Tab. 1: important properties of tested additives

product	mineral	d50 [μm]	d90 [μm]	BET [m <sup>2</sup> /g]	n	Fe <sub>2</sub> O <sub>3</sub> [% by weight]
TREFIL® 1313-400	anhydrite	6	16	2	1.57	0.10
TREFIL® 1313-600	anhydrite	3	7	3	1.57	0.10
SIKRON® SF 4000	cristobalite	5	15	4	1.48	0.03
MICROSPAR® 1380-600	feldspar	3	9	6	1.53	0.04
MICROSPAR® 1379-300	feldspar	10	32	2	1.53	0.04
MICROSPAR® 1379-350	feldspar	6	19	2.5	1.53	0.04
MICROSPAR® 1379-400	feldspar	4.5	15	4	1.53	0.04
MICROSPAR® 1379-600	feldspar	3	9	5	1.53	0.04

d50: medium grain size determined by laser diffraction (50 % passage); d90: top cut (90 % passage); BET: surface; n = refractive index (literature); Fe<sub>2</sub>O<sub>3</sub> = iron oxide content

## RESULTS & DISCUSSION

The results of the various tests are presented below:

### Results anti-blocking films

Tab. 2: Dynamic coefficient of friction  $\mu_D$

Product	inside against itself	outside against itself	inside against stainless steel	outside against stainless steel
UNFILLED	0.48	0.42	0.45	0.40
TREFIL® 1313-400	0.46	0.45	0.32	0.34
TREFIL® 1313-600	0.43	0.37	0.22	0.24
SIKRON® SF 4000	0.46	0.43	0.27	0.31
MICROSPAR® 1380-600	0.38	0.38	0.28	0.30
MICROSPAR® 1379-300	0.48	0.46	0.28	0.31
MICROSPAR® 1379-350	0.46	0.44	0.28	0.29
MICROSPAR® 1379-400	0.47	0.40	0.26	0.26
MICROSPAR® 1379-600	0.39	0.38	0.32	0.32

Tab. 3: Optical properties

Product	$T_{nh}$ [%]	$T_{nn}$ [%]	$T_{nd}$ [%]	Haze
UNFILLED	91	79	12	9
TREFIL® 1313-400	91	78	13	11
TREFIL® 1313-600	91	76	15	12
SIKRON® SF 4000	91	77	14	11
MICROSPAR® 1380-600	91	76	15	11
MICROSPAR® 1379-300	91	71	20	11
MICROSPAR® 1379-350	91	72	19	11
MICROSPAR® 1379-400	91	70	21	12
MICROSPAR® 1379-600	91	77	14	10

$T_{nh}$  = total transmission (normal-hemispheric);  $T_{nn}$  = directional transmission part without detection of diffuse part (normal-normal);  $T_{nd}$  = calculated diffuse part of transmission (normal-diffuse;  $T_{nh} - T_{nn}$ )

The results of the coefficient of friction show very good anti-blocking properties due to the use of our additives. MICROSPAR® products performed particularly well and deserve special mention. Optical properties also show very good results, again the MICROSPAR® series stands out from other products.

## Results agricultural films

Tab. 4: IR measurements

Product	Transmission [%]
UNFILLED	83.3
MICROSPAR® 1380-600	36.0
MICROSPAR® 1379-300	37.8
MICROSPAR® 1379-350	36.5
MICROSPAR® 1379-400	39.7
MICROSPAR® 1379-600	34.2

Tab. 5: Optical properties

Product	T <sub>nh</sub> [%]	T <sub>nn</sub> [%]	T <sub>nd</sub> [%]	Haze
UNFILLED	91	81	10	11
MICROSPAR® 1380-600	90	44	46	39
MICROSPAR® 1379-300	90	36	54	45
MICROSPAR® 1379-350	90	37	53	44
MICROSPAR® 1379-400	90	44	46	38
MICROSPAR® 1379-600	90	41	49	44

T<sub>nh</sub> = total transmission (normal- hemispheric); T<sub>nn</sub> = directional transmission part without detection of diffuse part (normal-normal); T<sub>nd</sub> = calculated diffuse part of transmission (normal-diffuse; T<sub>nh</sub> – T<sub>nn</sub>)

The results of the agricultural films show that the use of our additives can significantly improve the thermicity in the greenhouse. In this way, the energy costs in the greenhouse can be significantly reduced.

The total transmission in the visible wavelength range is only slightly influenced by the use of our additives.

Too much direct light can have a harmful influence on plant growth. This means that a higher proportion of diffuse light has a positive effect on plant growth. This higher proportion is achieved through the use of our additives.

## APPENDIX

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### Test procedure

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#### Film production

A 60 % masterbatch of a polyethylene with a MFI of 2.0 g/10 min was produced from the different additives.

The films were then produced in a blow film process with an additive concentration of 3,000 ppm for the antiblock films and 10 % for the agricultural films and a thickness of 50 µm from a polyethylene with an MFI (190 °C/2.16 kg) of 0.75 g/10 min and the masterbatch.

#### Determination of the dynamic coefficient of friction

Test standard:	DIN EN ISO 8295
Test direction:	lengthwise
Test speed:	100 mm/min
Number of individual values:	3

#### Determination of optical properties

Test standard transmission:	EN 410
Test standard haze:	ASTM D1003
Light transmittance:	380 nm – 780 nm
Applicance:	UV/VIS/NIR Spectrometer Lambda 950S from Perkin Elmer

#### Determination of thermicity

Applicance:	FT-IR Spectrometer NICOLET 6700 Thermo Scientific
Wave number range:	1,400 to 700 cm <sup>-1</sup>

## Diagrams of measurements

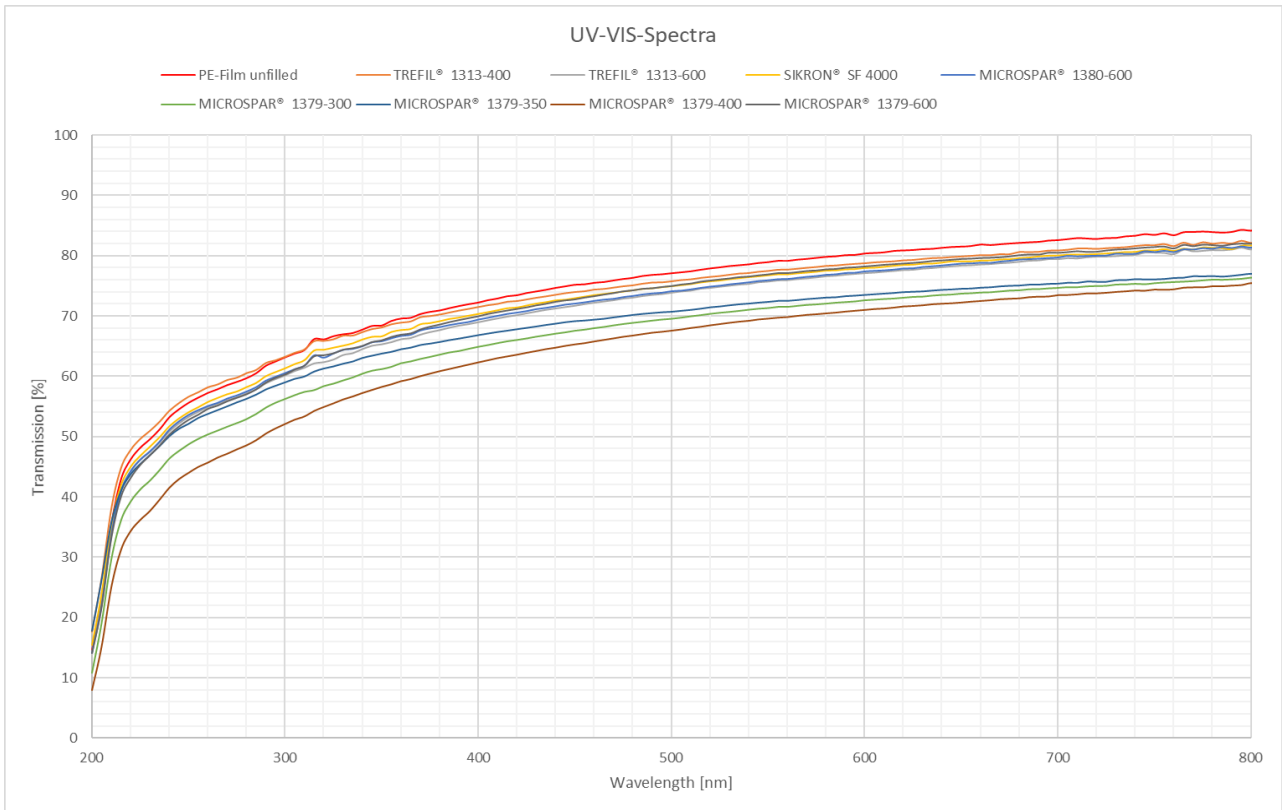


Fig. 1: UV-VIS spectra of antiblock films

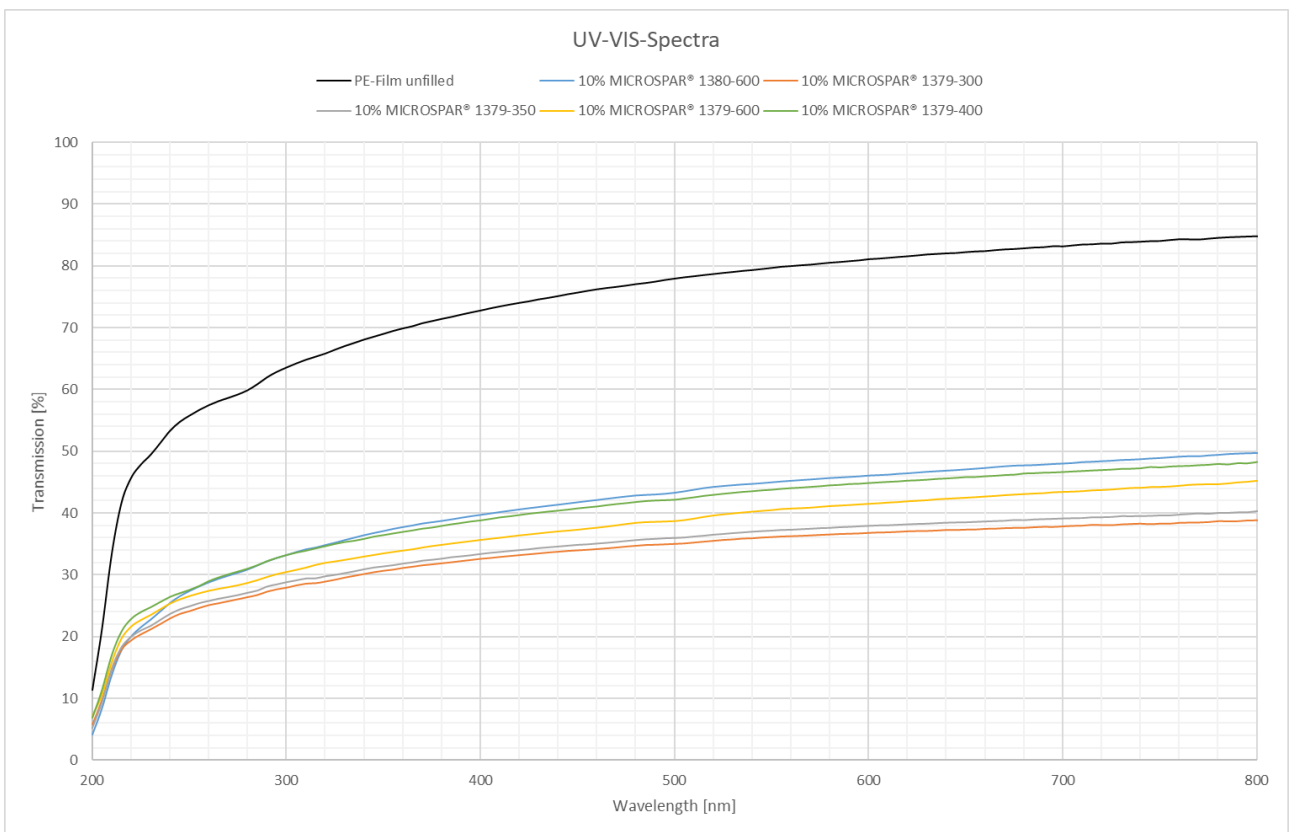


Fig. 2: UV-VIS spectra of agricultural films

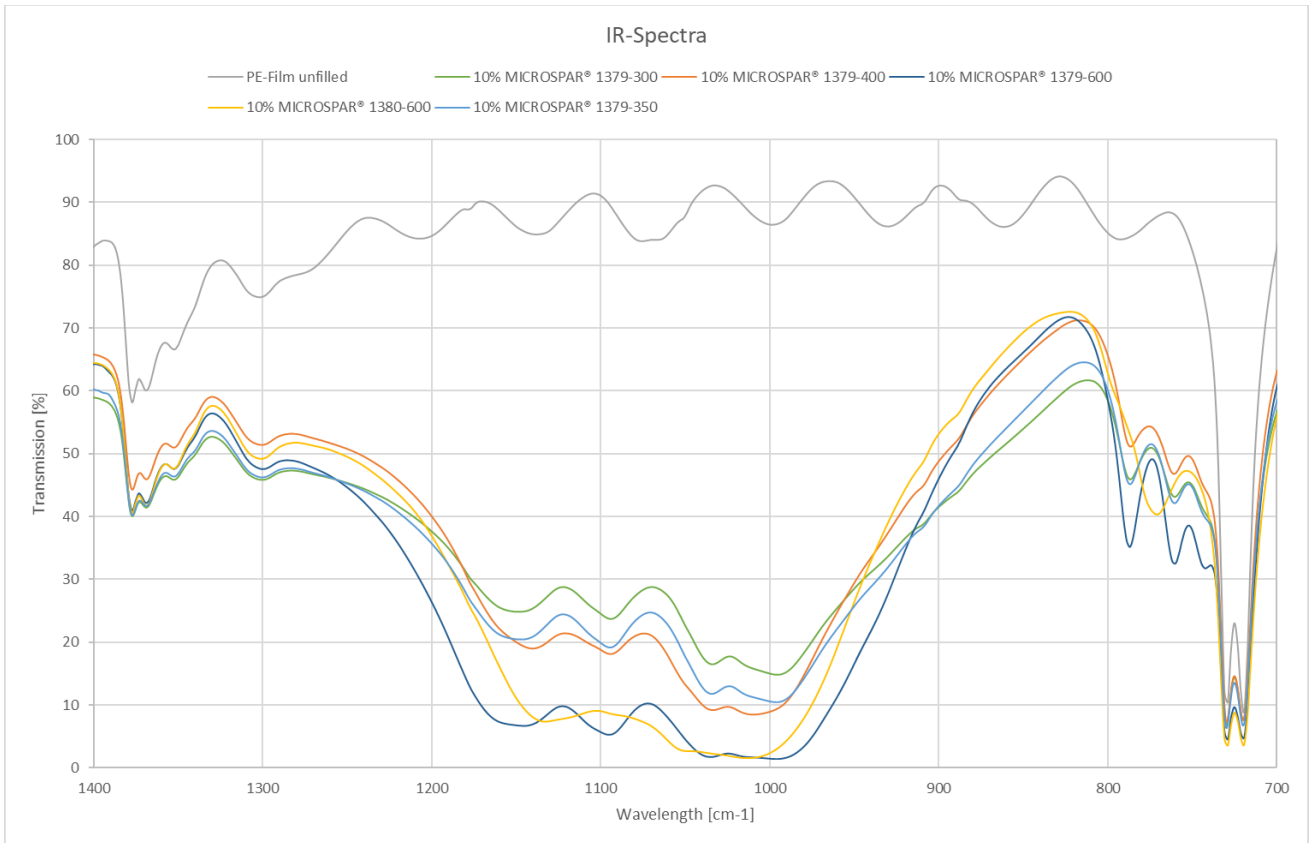


Fig. 3: IR spectra of agricultural films

The values given in this Technical Information have been determined and presented to the best of our knowledge. However, we ask you to understand that we accept no liability for the results and for the suitability and completeness of our recommendations and cannot guarantee that no industrial property rights of third parties are infringed. In the case of trial products, we cannot guarantee that production will commence at a later date. Please do not hesitate to contact us for further advice.