

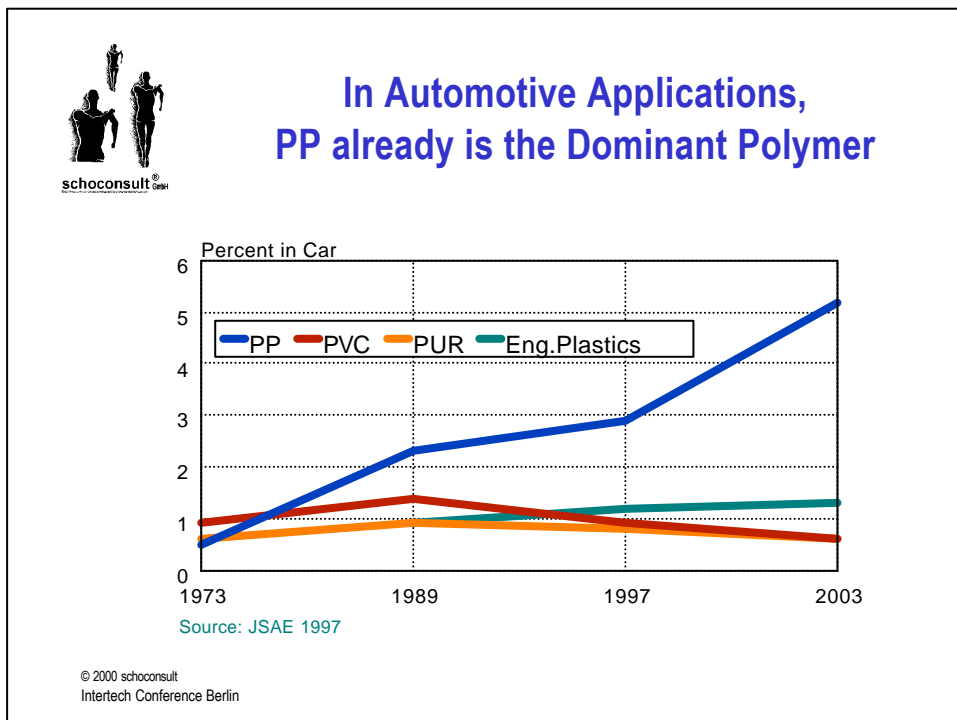
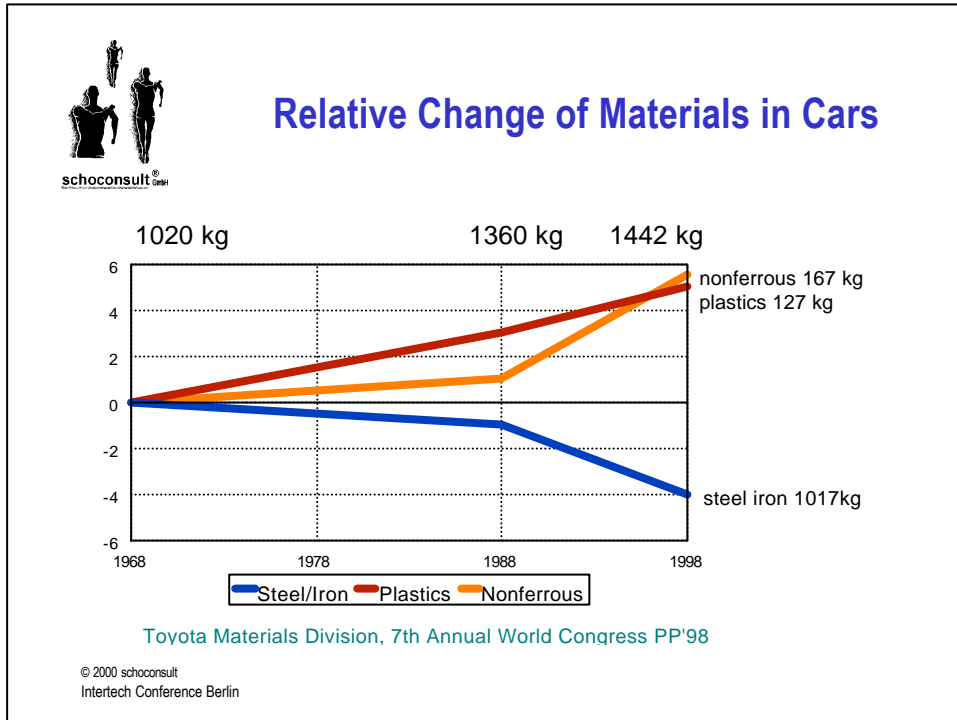
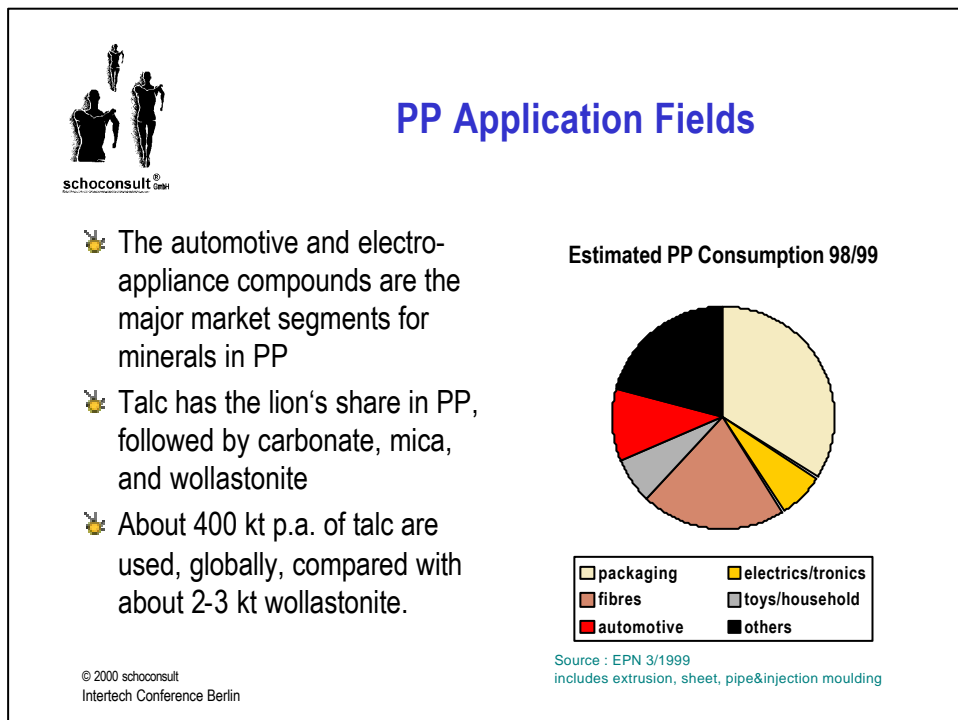
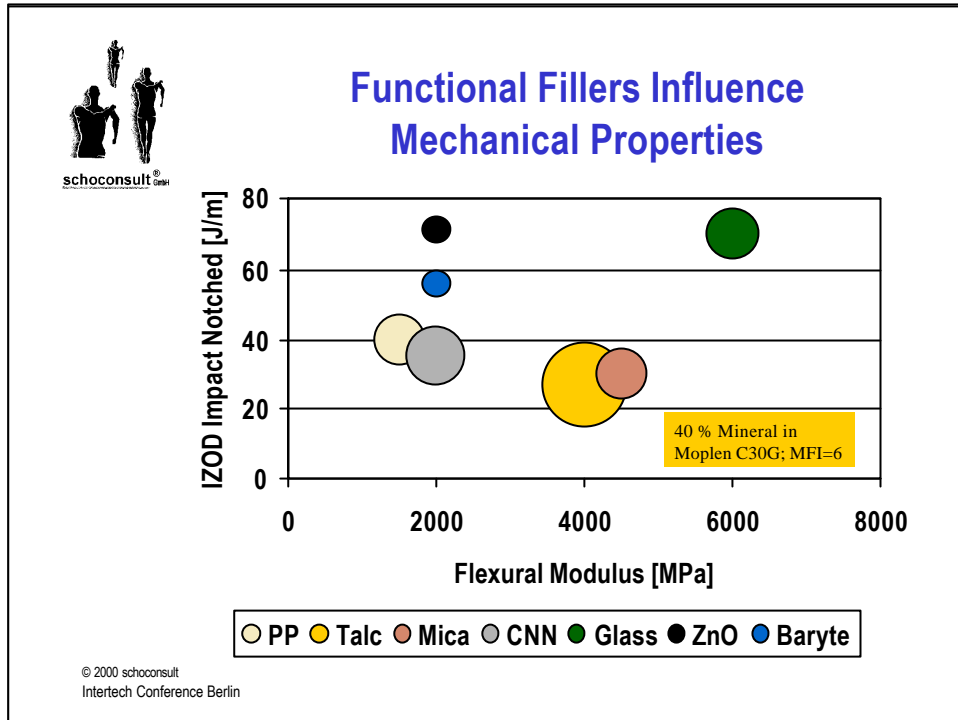


Intertech Conference Berlin 2000
W.Schober „ The Trend in Automotive PP-compounds calls for
Submicron Functional Minerals“

 <p>schoconsult GmbH</p>	<h2>The Trend in Automotive PP-compounds Calls for Submicron Functional Minerals</h2>
<p>Schoconsult GmbH A-8045 Graz Tel. +43 316 692072 Fax.+43 316 6920724</p>	<p>by Dr.Wilhelm Schober wilhelm.schober@schoconsult.com Intertech Conference Functional Effect Fillers for Reinforcing Polymer Systems Berlin, 13-15 September 2000</p>

 <p>schoconsult GmbH</p>	<h2>PP started in the 70-ies</h2>
	<ul style="list-style-type: none">✚ In the 70ies, the main objective to use plastic bumpers was the weight reduction of more than 20 % that could be obtained against ferrous materials. Fiat was the first, soon followed by VW and the Japanese car producers.✚ 25 years later, PP and its modifications have nearly total penetration in bumper facias in Europe and Japan; USA starts.✚ In addition, PP also enlarged the applications to exterior, interior and under the bonnet applications.✚ The standardization trend gives further potential to PP.
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Minerals' Performance

	Talc	Mica	Wollastonite	Calcite
Stiffness	++++	++++	++++	+
Impact Resistance	+	+	++	++
Shrinkage	++++	++	+	++++
Scratch & Mar Res.	+	++	++++	+
Colour	+++	+	+++	++++
Aspect Ratio	1:15-25	1:30-70	1:3-15	1:1-2
Fineness (D50) [μ]	0.5-15	20-100	4-45	2-10
Fineness (D98) [μ]	5-40	40-200	15-100	10-40

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PP Resins & Talc

- ✎ Standard talc products for automotive applications have a fineness of 30-40 μ topsize
- ✎ Resins are homo- and copo PP
- ✎ Mineral filling rates are common between 20-40%
- ✎ Applications are under the hood, and interior parts are common
- ✎ Today, higher performance resins are available,
- ✎ lower mineral filling rates are possible with same compound performance
- ✎ Bumper may contain mineral filler; 6-12% talc are used in Japan; 10-20% in Europe
- ✎ In Japan also some special micas (purified, delaminated, very fine) as well as nanoclays are used for trials

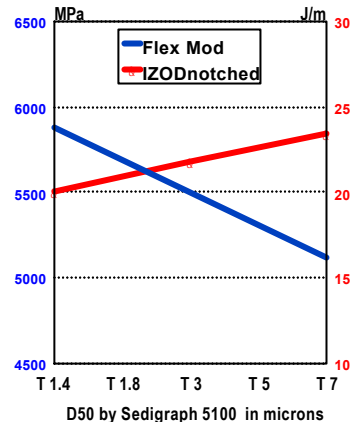
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Fineness Increases Stiffness

- In general, minerals such as talc and mica are able to increase stiffness in homo and copo-PP, if going finer
- This trend is also used to reduce filling rates; consequently the compound density and weight goes down, but maintaining the level of stiffness of the end use part
- Low shrinkage / CLTE is another target
- However, this significant increase does not continue always if going finer and finer

40 % Talc in Hostalen PPN4160

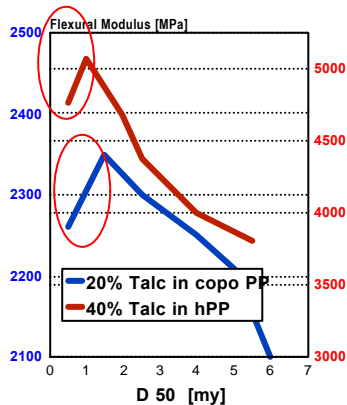


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Is Performance Limited ?

Influence of Fineness vs. Flex Modulus



- We realized that some talc products in the market are fine, but do not perform very well
- This depends on compounding conditions, the resins used, but also due to micronizing technique for talc, its mineralogy and shape factor
- In addition, there also seems to be a strong influence by surface properties of the processed minerals which lead to agglomeration

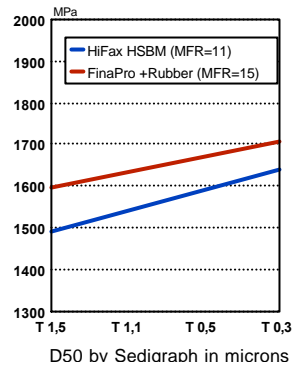
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Submicron Talcs in TPO Increase Flexural Modulus

- R-TPO and standard TPO (PP+rubber) show about the same improvement in stiffness if going finer with specialized HiTalc® Products
- However, the improvement is small
- the addition of fine and submicron talcs has other goals for TPO...

10% HiTalc filled TPO Flexural Modulus



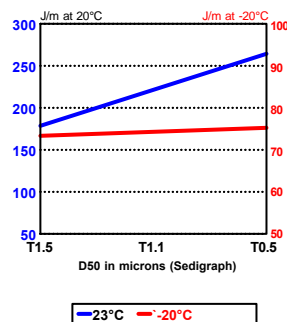
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Submicron Talc+ Impact Resistance

- R-TPO shows a remarkable effect, and finer talc (10-15%) also improves 23°C impact resistance, and stays stable at -20°C
- The high quality TPO (10-20% rubber+PP) with 10-20% talc did not show a significant positive effect by increasing talc fineness, as all impact values are so good and were dominated by the high rubber content
- Nevertheless the shrinkage is reduced significantly

IZOD Impact Notched 12% talc filled R-TPO (HiFax HSBM)



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Talc Fineness Development for PP in Europe

- ✦ Technically driven, talcs used today are getting finer and finer
- ✦ Ongoing technological developments in mineral processing enable an economic production of micronized and submicron talcs; therefore the cost performance is good
- ✦ Increasingly, the compounding industry takes advantage of this trend

Topsize of Talc	Trend
> 40 μm	↘
25-30 μm	↘
15-20 μm	↗
10-15 μm	→
7-10 μm	↗
< 7 μm	↑

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Innovation by Automotives

- ✦ The automotive industry is always open for innovations;
- ✦ compound performance and total costs of application count
- ✦ Very fine talcs have been used in Japan much longer than in Europe; North America is at its beginning
- ✦ The TSOPs demanded such fine minerals products about 10 years ago
- ✦ The electro-appliance market is more conservative and cost driven and stays with standard fineness micas, carbonates and talcs

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Japanese Compounds Lead the Way - TSOPs

- ✎ In Japan, quite different compounds were used for automotives compared to Europe and the USA
- ✎ Basically, different types of talcs were used; however, these products are produced in small lots and have high costs
- ✎ IMI Fabi, an Italian talc producer with international participations (HiTalc Group), started to produce this kind of talc products and went furtheron with the development of submicron versions

TSOP 1 -since 1991

Stiffness	1,500 MPa
MFR	18 g/10 min
HDT	110°C
IZOD -30°C	70 J/m
BT	- 35°C

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Bumper Concepts

Swedish/German OEMs Japanese OEMs



-) Europe is construction and safety driven
-) Japanese automotive industry is cost and concept driven

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Bumper Materials Development

		type 1	type 2	type 3	type 4
MFI	g/10min	6	7	14	10
Flex.Modulus	MPa	550	950	1500	1740
IZOD -20°C	J/m	NB	120	115	289
CLTE	°C * 10-5	> 8	8	4	5
Density	g/cm3	0,9	0,89	0,99	1,04
typical resin		CA 43A	SP179	HSBM	DG148; BB47F

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Montell „Trends in Automotive Applications for Filled PP“



TPOs- Rubber & PP

Starting formulation
 with IMI Fabi Talc CM2P

- ✎ Low shrinkage and zero gap, a good paintability and excellent flow for bigger parts need excellent resins and mineral fillers like talc, wollastonite
- ✎ Thermoplastic olefins are traditionally manufactured by mechanical blending of copo- PP + rubber in a compounding process with the mineral

Stamylan PPHC31+additives	55,0
Keltan 740P	20,0
Talc CM2P	25,0
MFI [230°C; 2,16kg; g/10']	4-5
Tensile Modulus [Mpa]	2.100
Flexural Modulus [MPa]	1.630
Izod Notched 23°C [J/m]	480
CLTE [mm/mm]	7,7xE-5

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R-TPO has certain Advantages

- ✎ In-reactor TPOs show higher consistency, as elastomers are finely dispersed;
- ✎ show improved physical properties + melt uniformity
- ✎ Submicron talcs are also used in these formulations to get the right performance

Bumper Starting formulation with HiTalc

Hifax SP179 [%]	97.4
HiTalc HTP05 [%]	12.0
Additives [%]	2.6
MFI [230°C; 2,16kg; g/10']	8
Tensile Modulus [Mpa]	1.900
Flexural Modulus [MPa]	1.720
Izod Notched 23°C [J/m]	620
Shrinkage II [%]	1,3
Shrinkage I [%]	1,8

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Submicron HiTalcs are the Benchmark

- ✎ TSOP #1 type of compounds are only possible with special talcs, most preferably submicron talcs
- ✎ Fineness is one property, there are also other items to be considered
- ✎ HTPultra-serie of IMI Fabi meets these requirements



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There are many Types of Talc

- ✎ Today, more than 500.000 t of talc are used for plastics applications
- ✎ Today, little of the white talc is supplied from regional sources in North America and Europe; most of the white talcs have to be imported from China and Australia;
- ✎ Talcs are differing significantly from one to the other mine and even within the same orebody
- ✎ Exotic small talc sources do not seem to be reliable enough in order to justify approval work at compounders, as these mines may soon disappear from the market place

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Microcrystalline Talcs are not proposed for PP compounds

- ✎ Microcrystalline Talcs are mined at Three Springs (Australia) and Montana (USA)
- ✎ These products are also lamellar but with high specific surface
- ✎ Mechanical performance is good, but thermal stability is extremely low as stabilizers are adsorbed



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Chinese Talcs vary in Quality

- ✦ China has a variety of talc products; only limited tonnages are of pure and high quality
- ✦ Northern Chinese Talcs (Liaoning) are bright, but often have a higher loss on ignition compared to
- ✦ Southern Chinese (Guangxi) talcs; these products often have a color consistency problem + black specs



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Hi Talc – High Purity Talc

- ✦ HiTalc products are based on Mount Seabrook (Australia); this mine is a JV of IMI Fabi (Italy) and Commercial Minerals (Australia)
- ✦ Material is lamellar, of high purity (99% talc), consistent in colour
- ✦ Large deposit, a reliable long term source, and having good access to a deep sea port



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Colour & Consistency – a Big Issue

- ✎ Most talc producers specify
 - their talc products' brightness as a „dry“ powder; however, this powder brightness is not representative for the compound brightness
 - they are selling according to a technical datasheet, feeling free to blend all types of local and imported talcs, independent from a specific mine
- ✎ IMI Fabi specifies their talcs per mine and is able to offer colour and lot consistency

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Southern Chinese Talcs



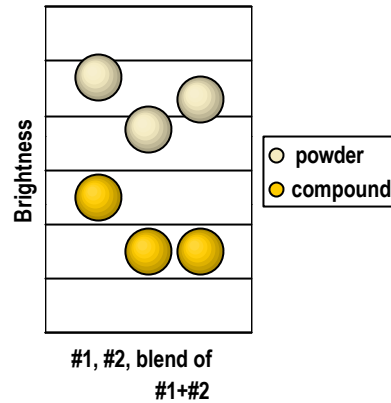
- ✎ This is a typical mix of very bright and lower brightness lump talc stones as imported from Guangxi and ground in Europe and the USA
- ✎ The best stones go up to 95 brightness; the lower quality is between 85 and 88

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Blending Creates Headache

- ✎ Talc Spec as powder („dry“)
Y= 90 at 20 my tosize
- ✎ Imported talc # 1 = 92-94;
Imported talc # 2 = 86-88
- ✎ Spec is guaranteed only
as „dry“ and produced
by blending raw materials
- ✎ Compound brightness
always shows the
dominance of the darker
component

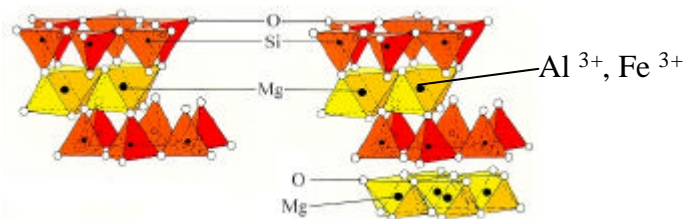


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Impurities & Thermal Stability

- ✎ The mineral impurities have influence concerning the heat ageing properties
- ✎ Heavy metals show interactions, depending where they are located
- ✎ As long as they are in the crystal lattice, they create less problems
- ✎ Increasing fineness has a strong influence as more reactive edges at the platelets are offered for interaction

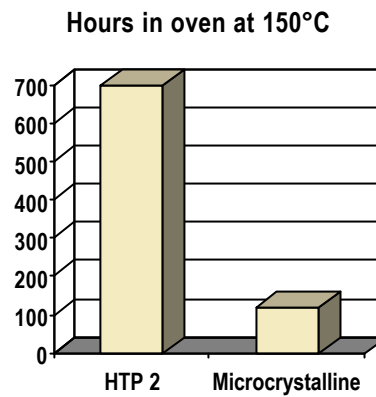


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Specific Surface & Thermal Stability

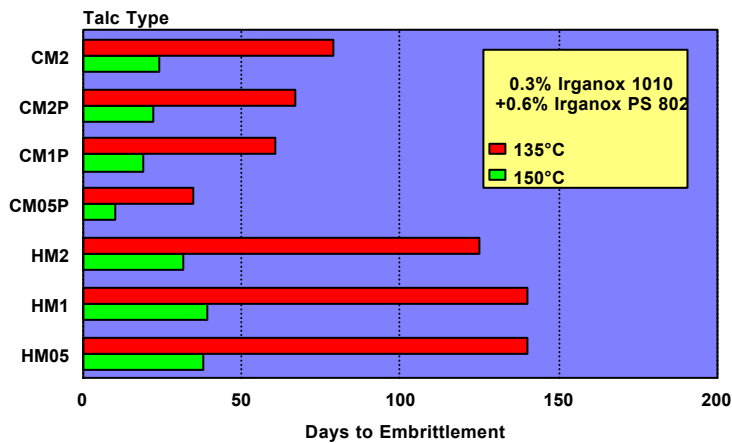
- ✦ The specific surface of talc products has a strong influence to thermal stability properties
- ✦ Microcrystalline talcs are a good example
- ✦ Both talcs are + 98 % talc, and < 1 % Fe-content, at same fineness of 20 microns topsize
- ✦ Microcrystalline talcs are able to adsorb more additives



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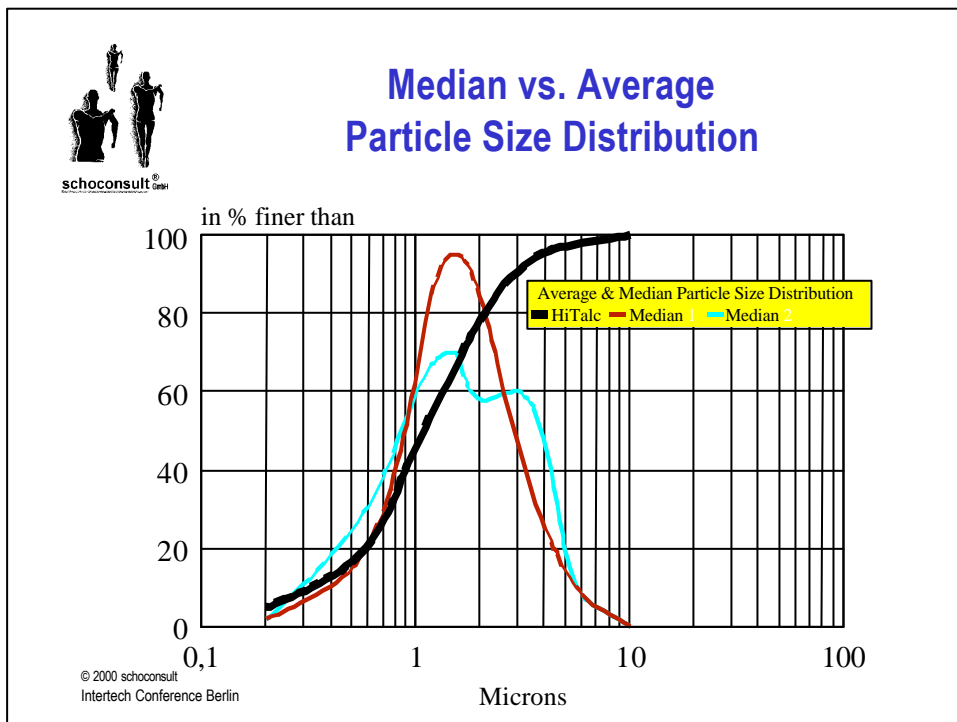
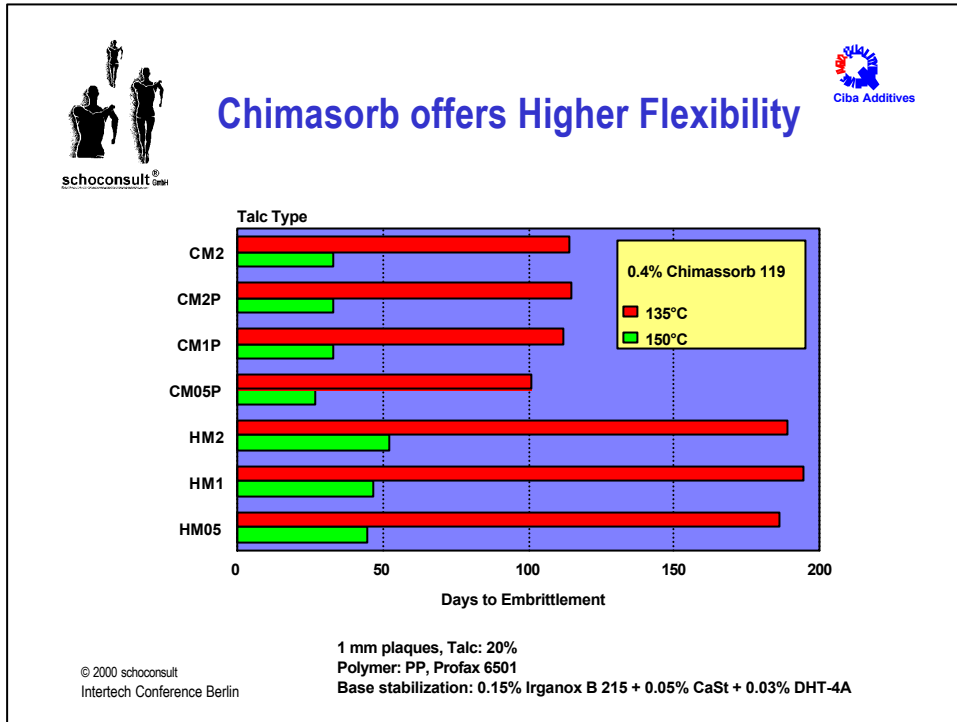


Thermal Stability vs. Fineness and Purity of Talcs



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1 mm plaques, Talc: 20%
 Polymer: PP, Profax 6501
 Base stabilization: 0.15% Irganox B 215 + 0.05% CaSt + 0.03% DHT-4A





Bulk Density vs. Feeding

- ✚ Submicron talc powders have a bulk density of 180 –220 kg/m³
- ✚ Such a fluffy powder makes problems in feeding at the extruder
- ✚ Compacted talcs are proposed to be used



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Compacted Talcs

- ✚ Micronized and submicron HiTalc products are designed to be compacted without chemical binders, offering excellent bulk density even after transportation in silo trucks
- ✚ Uniquely designed talcs to minimize feeding problems without effecting re-dispersion
 - Higher talc loading levels are possible
 - More accurate talc dosage is possible
 - Reduced mineral dust in plants

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Typical HiTalc Products

	Compacted Y/N	D-50 my	D-99 my	Bulk Lb/ft ³	Density g/cm ³
HTPultra5	N	0.5	5-6	11	0.18
HTPultra5c	Y	0.5	5-6	56	0.90
HTPultra10	N	1.1	6-7	13	0.21
HTPultra10c	Y	1.1	6-7	56	0.90
HTP05	N	1.4	10	16	0.25
HTP05c	Y	1.4	10	56	0.90
HTP1	N	1.9	12	16	0.26
HTP1c	Y	1.9	12	56	0.90

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Nano-Composites

- ✎ This is a hot case and many hopes are created.
- ✎ However, there are not a lot of other minerals available under one micron and suitable for the use in automotive PP-compounds.
- ✎ In Japan, we found some purified, really fine micas as well as days, and some industrial trials already started.
- ✎ Nanocor-USA promotes some clays and has already some industrial trial references.
- ✎ However, no polyolefin nanocomposite has gone commercial so far, according to our knowledge.

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Nano-Clays

- ✎ The basic idea is to reduce amount of fillers in the PP and TPO compound maintaining the same mechanical and thermal properties;
- ✎ scratch and mar resistance could be improved as filler loadings are lower
- ✎ 7% nanoclay are targeted to give the same property as a 20 % standard talc (30-40 microns topsize) = -13%
- ✎ If submicron talcs are used the gap becomes much smaller (5-7% only ?)
- ✎ The low polarity of the PP and TPO resin limits interaction between modified nanoclays and the polymers
- ✎ Surface modifications are essential to overcome this fact
- ✎ This could be silane or maleic anhydride
- ✎ Costs of nanoclays are 5-7 times higher than submicron talcs
- ✎ In Japan, there are already PP-bumpers formulated with 7-9% talc only, which reduces the chances of nano-clays

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Development Cooperation

- ✎ Compounders have to meet increasingly higher and tighter specifications
- ✎ Mineral producers have to be aware that they have to contribute with adequate sensitivity concerning quality
- ✎ Mineral producers have to be part of product development procedures at compounders, as mineral specifications have significant impact on compound performance
- ✎ A long term partnership between multinational compounders and their mineral suppliers on a global basis will become inevitable

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The Future = Specialty Talc Products

- ✎ We expect that the compacted submicron talcs will become the standard for automotive applications within short time – for interior, exterior applications and bumpers
- ✎ Only purest talcs will be used for submicron products
- ✎ The worldwide production of these mineral products become inevitable– using identical raw materials + technology for processing, using the same specifications
- ✎ So far, only the HiTalc Group has a global source of talc, based on Australian Mt.Seabrook, with processing in Europe, USA and Australia.