Performance of Submicron Talc in PP Compounds

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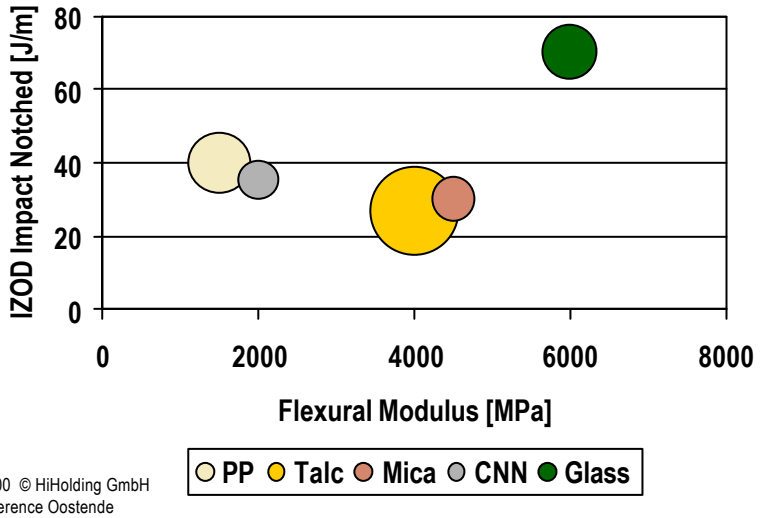
Functional Fillers Influence Mechanical Properties



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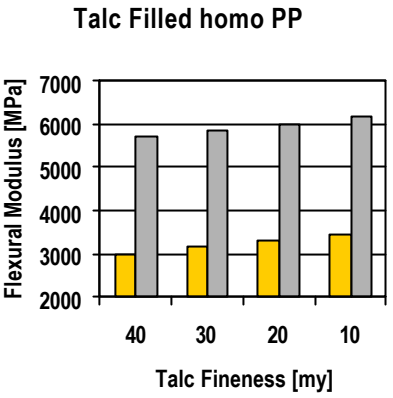
Talc Provides Stiffness

- Talc improves stiffness of the PP compound depending on fineness and shape of the mineral (aspect ratio)
- Impact values are also influenced by fineness, but generally lower
- Example : talc in hPP grey=40%, yellow = 20%



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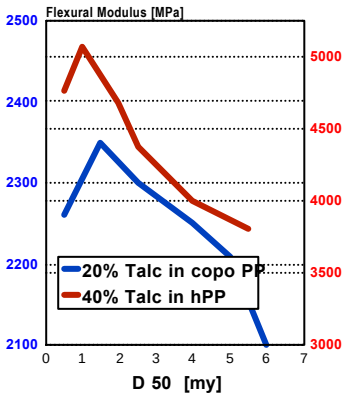
Is Performance Limited ?

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, but also due to micronizing technique, mineralogy and shape factor
- In addition, there also seem to be a strong influence by surface properties which lead to agglomeration

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There are many Types of Talc

- Today, more than 400.000 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 small tonnages are pure and of high quality
- Northern Chinese Talcs (Liaoning) are bright, but 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 and Commercial Minerals
- Material is lamellar, of high purity (99% talc), consistent in colour
- Large deposit, a reliable long term source, having good access to a deap 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 best 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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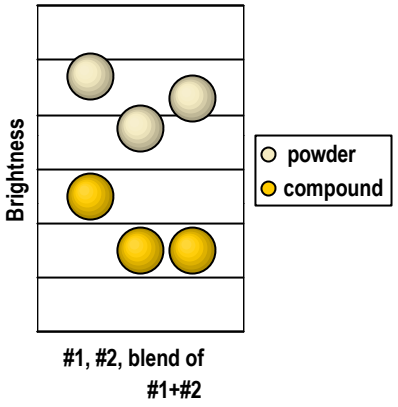
Blending Creates Headache

- Talc Spec as powder („dry“) Y= 90 at 20 my topsize
- 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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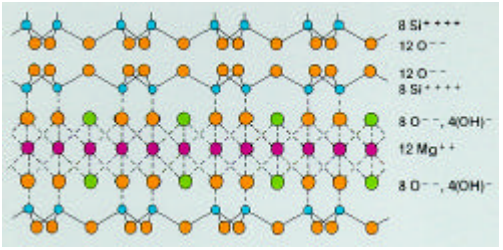
Impurities & Thermal Stability

- 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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Mineralogy & Morphology Fineness & Fe-content

	1	2	3	4	5	6
	Australia	Australia	India	Italy	China	Italy
D-98	20 my	20 my	10my	20 my	20 my	30 my
talc [%]	98	98-99	97	92	99	60-65
chlorite	2	1	2	5	1	20-25
carbonate	0	0-1	1	2	0	13-15
morphology	microcrystalline	platy	platy	platy	platy	mixed
Fe [%]	1	0,7	0,6	0,9	0,2	2,8
BET [m2/g]	15	9	10	7	8	4
stability at 150 °C [d]	8	40	28	40	40	26

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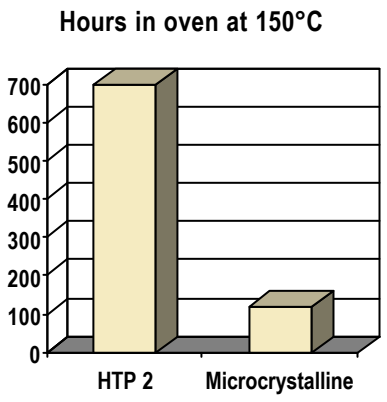
Specific Surface & Thermal Stability

- 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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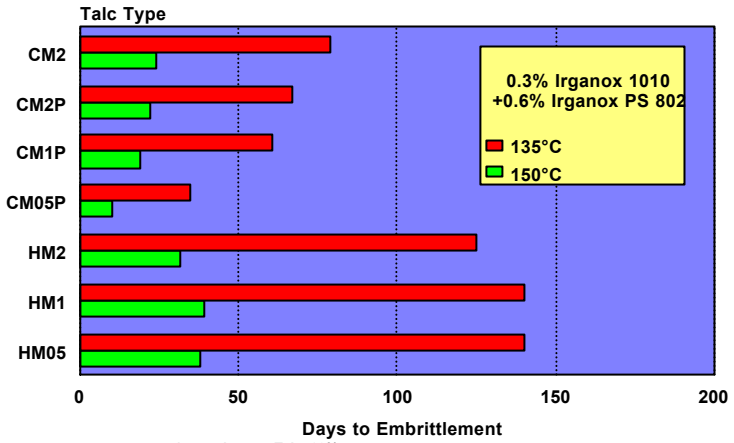
Thermal Stability vs. Fineness and Purity of Talcs



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

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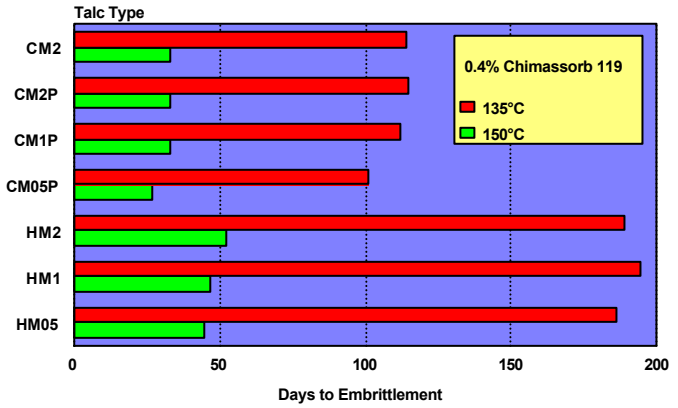
Chimasorb offers Higher Flexibility



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The Trend to Finer Talc Products

- We can see a constant trend to finer products over the last decade
- 40 and 30 micron top-size products are only used for electro appliances, standard trim parts ; most of the talc used today for PP compounds are 20, 15, 10 my and finer
- In terms of D50 the trend started at 10-12 my and moved finer to 4-3-2-1 my; the available submicron talcs go as fine as 0,5 my

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Delamination of Talc

- Delamination is key to success for high quality talc products
- Sophisticated micronization equipment is needed to produce submicron talcs
- Aspect ratio is important as well as a low affinity for agglomeration
- IMI Fabi is the first producer of submicron talcs in Europe

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Japanese Compounds Lead the Way - TSOPs

- In Japan, quite different compounds were used for automotive applications compared to Europe and the USA
- Basically, different types of talcs were used – , of high purity, much finer and the particle size distribution curves showed a different shape; however, these products are produced in small lots and have high costs
- These products initiated the development work at IMI Fabi in order to develop submicron talcs to be produced on large scale at industrial conditions

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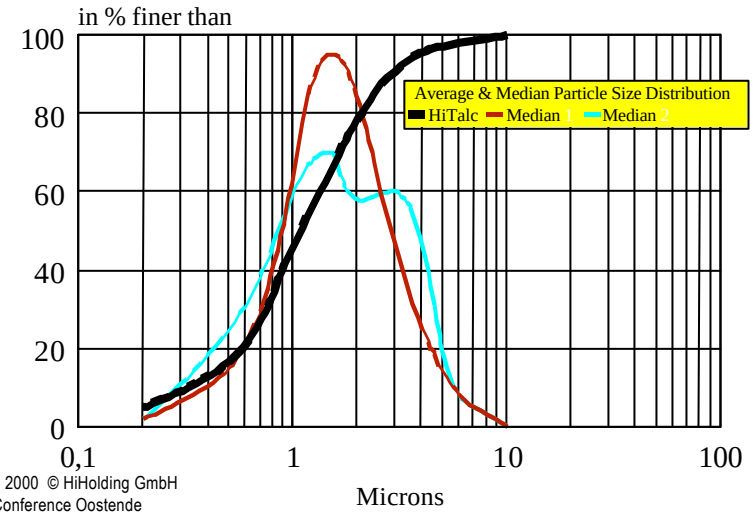
Median vs. Average Particle Size Distribution



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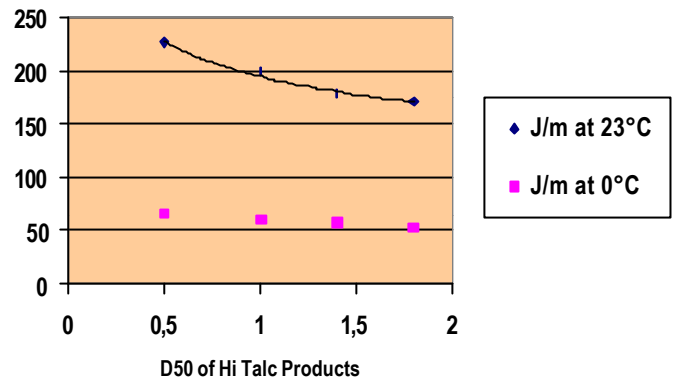
Performance of Submicron Talcs D50 vs. Impact in PP



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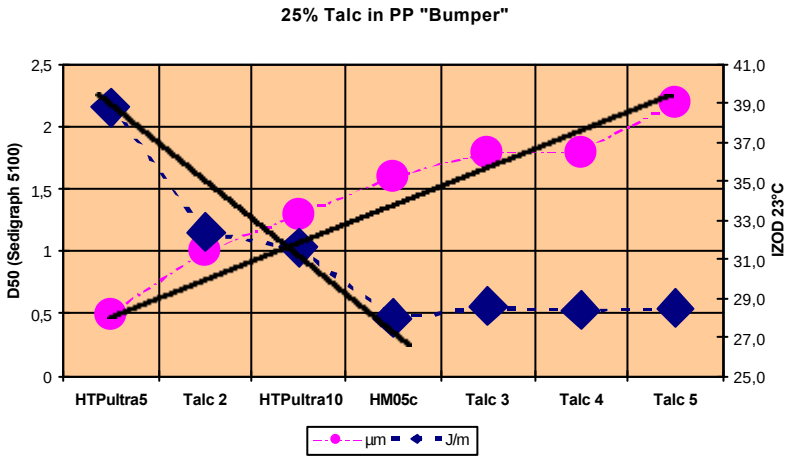
Submicron Talc Performance Trends IZOD Impact Resistance vs. D50



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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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Globalisation

- We live in times of globalisation – this is also very true for the compounding business
- The automotive and electro-appliance sectors are the driving forces
- Rationalisation and standardisation of raw materials takes place in order to generate economies of scale
- R&D work can be centralized for global components
- Product approval is only made once
- Production can easily be shifted to other production units all over the world
- The result : cheaper - higher flexibility - faster

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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 – for interior 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
- The HiTalc Group already has production centers in Europe and the USA using Australian Mount Seabrook talc; the Australasian region will follow

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