BYK

Whitepaper

New Generation Clay Technology for Efficient Polyolefin Reinforcement

Louis Martin and PJ Yoon
BYK USA Inc., 524 South Cherry Street, CT 06492 Wallingford, United States
2021

A member of ALTANA

New Generation Clay Technology for Efficient Polyolefin Reinforcement

Louis Martin and PJ Yoon
BYK USA Inc., 524 South Cherry Street, CT 06492 Wallingford, United States

BYK-MAX CT 4270

Product Type
Organically modified clay

Application
TPO and PP compounds

Key benefits
- Reduced density/mass reduction
- Increased scratch resistance
- Improved processability

The Challenge

To access a broad range of applications from TPO bumpers and interior/exterior automotive trim to many other durable goods, polypropylene (PP) needs reinforcement. Talc is often used to provide reinforcement because it is a low-cost option. However, as a mineral, talc has a higher density, increasing the density of compounds and overall part mass. Additionally, using talc in PP compounds reduces both scratch resistance and design flexibility (due to interference with the strength and appearance of knit/weld lines). While talc provides a low-cost reinforcement option, it does not enable decreased density and improved scratch resistance goals.

The Solution

BYK-MAX CT 4270 is a controlled blend of specific grades of clays (mixed morphology) that offers reduced density, increased scratch resistance and improved processability without negatively affecting part cost. Whereas 12-18 % of various grades of talc is required to meet desired physical properties, only 5 % of BYK-MAX CT 4270 is required. The physical property benefits of clay reinforcement have been recognized for many years. However, clay has been more expensive and has required the use of grafted PP additives and special processing to manufacture compounds. These have all increased the cost of using clay and prevented more widespread acceptance. To counteract these, BYK developed BYK-MAX CT 4270 using a proprietary blend of clays to provide greatly increased exfoliation using standard processing techniques. These factors combine to utilize the benefits of clay with no increase in part cost.

BYK-MAX CT 4270: Morphology Improvement

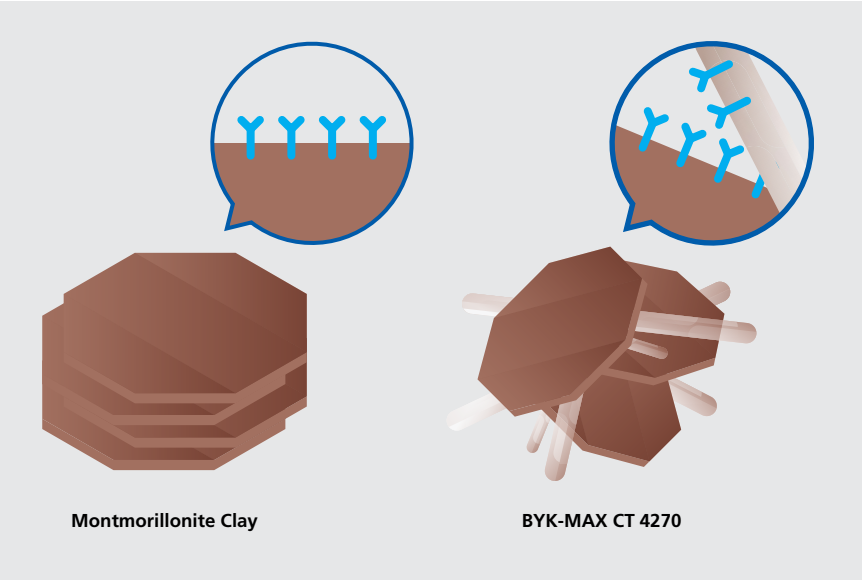


Figure 1

Reduced Density

Density reduction is an important trend in the automotive industry. Reducing the weight of vehicles results in improved fuel consumption, thus reducing the carbon dioxide emissions that are driving global climate change. Additionally, mass reduction will remain a key to the range of electric vehicles.

In an internal BYK study, bumper grades using BYK-MAX CT 4270 were developed and compared to commonly available bumper grades using talc. To match the properties of the 12 % talc compound only 5 % of clay was required, resulting in a 7 % density reduction.

BYK-MAX CT 4270 TPO Development Formulations

	Talc 12 % Control	**Goal**	**5% BYK-MAX CT 4270**			
Density	0.986	Minimize	0.923	0.920	0.923	0.918
Melt Flow Index	27	35+	23	25	21	23
Flexural Modulus (MPa)	1400	1600+	1600	1520	1241	1345
Izod Impact Strength 23 °C	55	55	21	23	36	32
Izod Impact Strength -30 °C	7.0	7	3.6	3.4	4.1	4.0
Dart Impact Strength 23 °C	264	264	280	256	264	264
Dart Impact Strength -30 °C	240 (DF)	240 (DF)	112 (BF)	152 (BF)	176 (DF)	216 (DF)
HDT at 0.45 MPa	102.5	-	100.0	101.0	94.2	96.6
HDT at 1.8 MPa	53	≥+50	55	56	54	56

DF: Ductile failure BF: Brittle failure

Figure 2

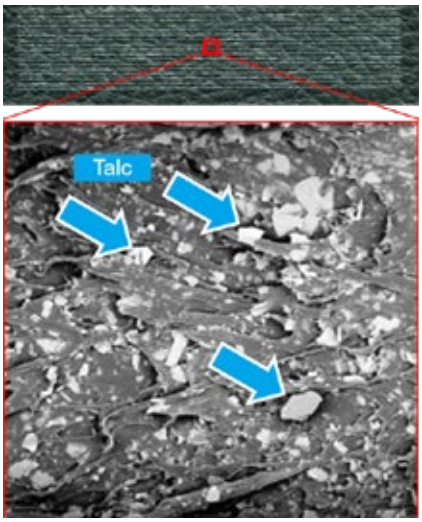
Increased Scratch Resistance

Similar to automotive exterior, both weight and cost reduction are key trends for interiors as well. In addition, removal of coatings reduces cost and the environmental impact of VOC during the coating application process. The transition to PP based materials for interiors reduces cost, weight and emissions. However, this transition has been hindered by the reduction in scratch resistance when using talc reinforced PP. Substituting BYK-MAX CT 4270 for the talc enables this transition without sacrificing scratch resistance.

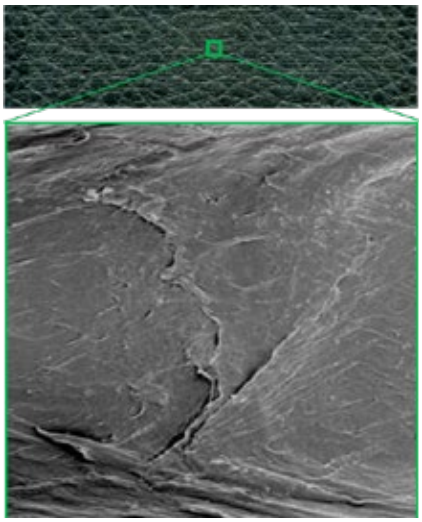
As can be seen in the example on the right, talc particles in the walls of the scratch are very visible and reflect more light making the scratches more visible than neat polymer. BYK-MAX CT 4270 does not produce the same effect due to its finer dispersion.

The Erichsen Five Finger Scratch test is commonly used to evaluate the scratch resistance of polymer surfaces. This test uses fingers with different loads to create scratches in the surface which are then evaluated using the lightness scale from a spectrophotometer. The greater the change in lightness from the unscratched to the scratched area, the more visible the scratch. The data below demonstrates how a system using BYK-MAX CT 4270 dramatically outperforms systems using talc.

BYK-MAX CT 4270 Scratch Performance Improvement



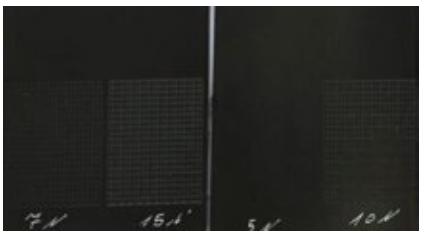
PP/talc: particles of about 10 micron are observed on scratch line



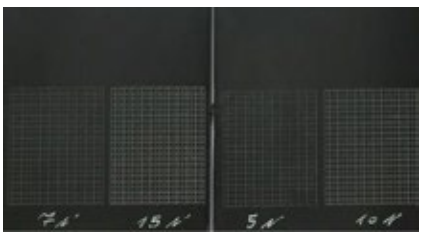
PP/BYK-MAX CT 4270: less whitening observed

Figure 3

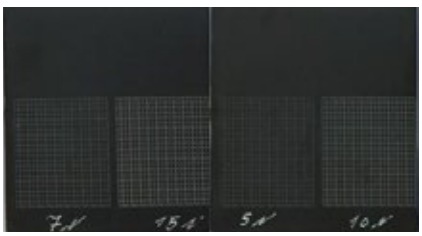
BYK-MAX CT 4270 Erichsen Scratch Test Improvement



BYK-MAX CT 4270 5%



Talc 6µm 18%



Talc 1µm 18%

Figure 4

BYK-MAX CT 4270 Erichsen Scratch Test Data

	BYK-MAX CT 4270 5 %	Talc 6µm 18 %	Talc 1 µm 18 %
ΔL 5 N force	0.0	1.2	1.2
ΔL 7 N force	0.2	1.9	1.6
ΔL 10 N force	0.3	2.6	2.2
ΔL 15 N force	0.5	4.1	4.1

Figure 5

Improved Processability

The processability of a material can enable molding thinner parts at shorter cycle times. This provides weight and cost savings. To enable this, a material must flow easily and set up quickly. The use of BYK-MAX CT 4270 as a reinforcement results in a material that flows more easily under injection molding pressure and enables lower molding temperatures. These lower temperatures shorten cycle times an average of 5 %.

Even though mold temperatures were decreased as shown in the table, max injection pressure was also reduced 10 %.

BYK-MAX CT 4270
Door Inner Panel Development

Figure 6

BYK-MAX CT 4270 Molding Condition Improvements

Material	PP/talc	PP/BYK-MAX CT 4270
Hot Runner	240 °C	220 °C
Nozzle	240 °C	210 °C
Middle	230 °C	205 °C
Rear	210 °C	200 °C

Figure 7

Conclusion

BYK-MAX CT 4270 is an excellent reinforcing agent for PP that doesn't suffer the challenges of talc. Replacing talc with BYK-MAX CT 4270 offers advantages that are important to the automotive industry including 7 % density reduction and improved scratch resistance for unpainted surfaces while maintaining other required physical properties. BYK-MAX CT 4270 provides these benefits at equivalent formula cost and additional savings through cycle time reduction enabled by lower molding temperatures.

Your contact person
Louis Martin, BYK USA
Global End Use Manager,
Thermoplastics Transportation
Louis.Martin@altana.com
+1 248-564-9255

BYK-Chemie GmbH
P.O. Box 10 02 45
46462 Wesel
Germany
Tel +49 281 670-0
Fax +49 281 65735

info@byk.com
www.byk.com

BYK USA Inc.
524 South Cherry Street
Wallingford, CT 06492
USA
Tel 203 265-2086
Fax 203 284-9158

cs.usa@byk.com
www.byk.com