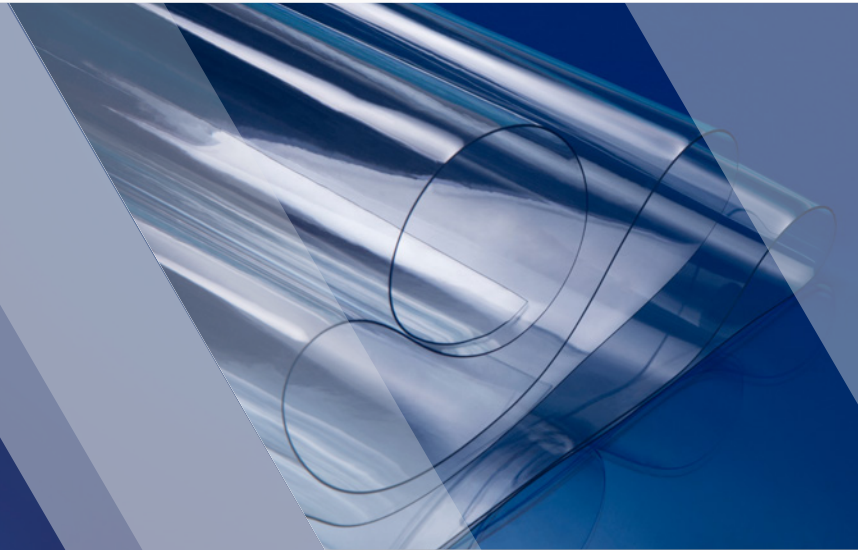


CAB-O-SIL® FUMED SILICA FOR TRANSPARENT RUBBER



For more than a century, Cabot Corporation has been delivering innovative materials to rubber customers. As one of the world's leading providers of performance additives, Cabot is committed to delivering products with superior quality, consistency, and performance. Our goal is to expand what is possible in rubber products, for example in polybutadiene (BR), styrene-butadiene (SBR), and isoprene (IR) rubber blends.



Key Benefits

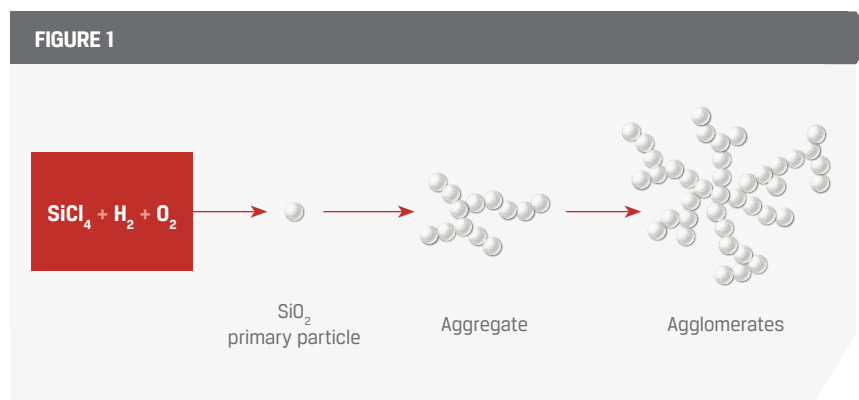
CAB-O-SIL® fumed silica enables customers to manufacture colorless, highly transparent rubbers which can be used in a variety of applications.

Benefits of Cabot fumed silica in IR/BR/SBR rubber blends include:



What is Fumed Silica?

Fumed silica, also known as pyrogenic silica, is an amorphous, synthetic silica produced by vapor phase hydrolysis of chlorosilanes in a hydrogen oxygen flame of over 1000°C. This produces a very pure homogeneous primary particle of silicon dioxide. In the flame process, primary particles are fused into branched, three dimensional aggregates (Figure 1). In the manufacturing process, aggregates collide and stick to form agglomerates. Fumed silica appears as a white powder with low bulk density.



The surface of untreated fumed silica has hydroxyl groups which make the surface hydrophilic. Fumed silica can also be made hydrophobic by chemically modifying the surface hydroxyl groups.

Transparency in rubber applications can be directly correlated to the surface area and dispersibility of the fumed silica. Generally silica products with higher surface areas which are dispersed uniformly produce better clarity. With CAB-O-SIL fumed silica, you can improve both clarity and mechanical properties, including tensile strength, and hardness.



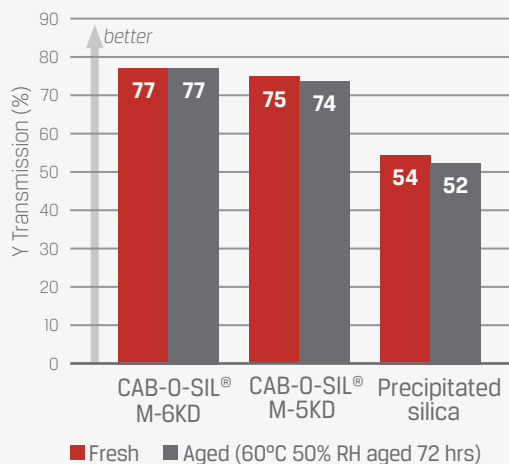
Application Overview

Rubber applications like tires, mechanical rubber goods (MRG), and footwear (shoe soles) account for the majority of the synthetic silica consumption in the rubber industry. Fumed and precipitated silicas are typically used as fillers to enhance the mechanical properties of rubber products to meet different product needs such as strength, durability and aging performance. On top of this, some emerging applications, including transparent shoe soles, also require the rubber products to achieve good optical and coloring properties.

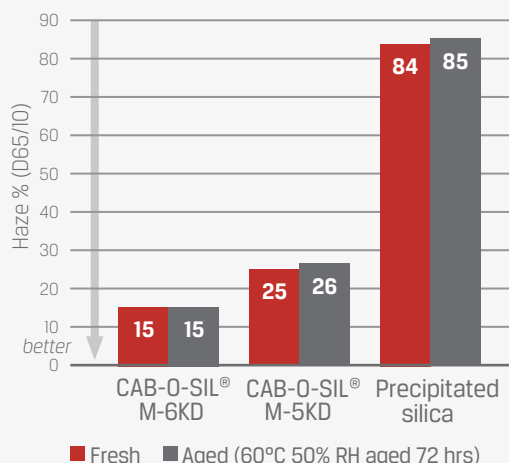
CAB-O-SIL® fumed silicas are designed to improve performance in clear rubber applications by providing a high level of reinforcement and transparency, and with minimal yellowing from aging. Cabot's fumed silicas facilitate the performance requirements of high-end transparent rubber applications such as clear shoe soles.

In Cabot's studies, CAB-O-SIL® M-5KD (200m²/g) and CAB-O-SIL® M-6KD (260m²/g) fumed silicas, and precipitated silica (200m²/g) were evaluated in a polybutadiene rubber, styrene-butadiene rubber, and polyisoprene rubber blend (BR/SBR/IR blend) typically used in sneaker out-sole rubbers. In comparison to precipitated silica, CAB-O-SIL® M-5KD and CAB-O-SIL® M-6KD fumed silicas exhibited improved reinforcement in the rubber compound. Fumed silica can also produce translucent or even clear, non-yellowing rubber products with minimal aging effect.

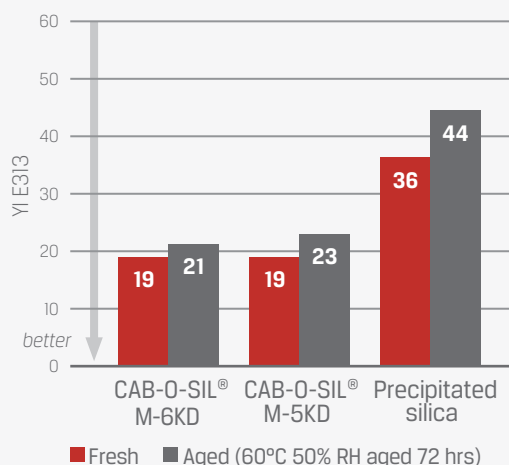
TRANSMISSION



HAZE



YELLOWING



Fumed Silica Performance and Positioning

Optical Properties

The transparent rubber application requires rubber goods to transmit visible light to meet aesthetic requirements. There are two primary parameters to characterize optical clarity of the rubber: transmission and haze. Transmission measures the ratio of transmitted light intensity to the incident light intensity. Higher transmission values indicate a better see-through property. Haze describes the rubber's fogginess level, which is defined as light scattering greater than 2.5° through a specimen (Wide Angle Scattering). A lower haze value indicates a better contrast of the image viewed through the rubber.

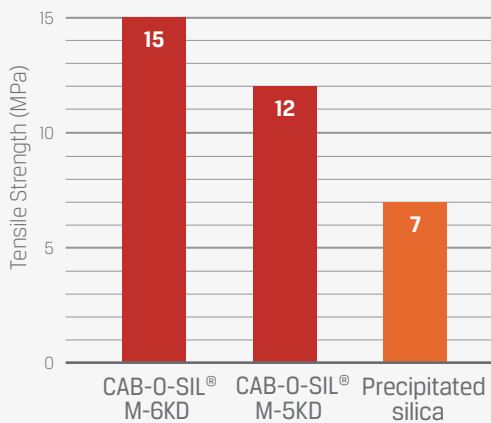
In these studies, both CAB-O-SIL® M-6KD and CAB-O-SIL® M-5KD fumed silicas provided superior clarity over precipitated silica in BR/SBR/IR blends, as indicated by high transmission and low haze values. Even after aging, there is no noticeable drop in both properties for fumed silicas, which makes them ideal fillers for clear rubber applications. Within these samples, CAB-O-SIL® M-6KD fumed silica shows the best transmission and haze properties, due to uniform dispersibility in the compounds. The highly transparent nature of fumed silica in rubber compounds makes it more adaptive in compounding clear and colored products, like shoe soles, belts and hoses.

Rubber can exhibit undesirable yellowing due to polymer degradation, which gives an old or dirty appearance to footwear or other rubber goods. CAB-O-SIL® M-6KD and CAB-O-SIL® M-5KD fumed silicas demonstrated a much lower yellowing index in comparison to precipitated silica in this study, and they also provided higher resistance against yellowing after aging. The nonyellowing feature of CAB-O-SIL® M-6KD and CAB-O-SIL® M-5KD can enhance color matching and retention during the lifetime of the rubber goods.

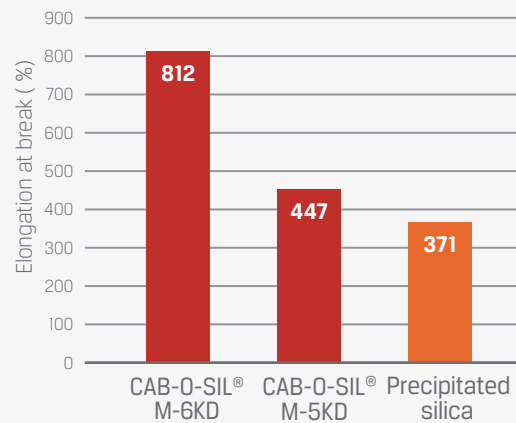
Mechanical Properties

CAB-O-SIL® M-6KD and CAB-O-SIL® M-5KD fumed silicas provided strong reinforcement in BR/SBR/IR rubbers, without making the rubber too hard to meet shoe sole application requirements. Both tensile strength and elongation at break for CAB-O-SIL® M-6KD and CAB-O-SIL® M-5KD fumed silicas are noticeably better than the precipitated silica. Within all three samples, CAB-O-SIL® M-6KD fumed silica demonstrated the highest reinforcement (high tensile and elongation) in the BR/SBR/IR blend rubber formulation in comparison to 200 m²/g surface area CAB-O-SIL® M-5KD fumed silica and precipitated silica grades in this study. The enhanced reinforcement of fumed silica in the rubber compound can be attributed to improved filler dispersion and their interactions in the matrix. For rubber applications with high mechanical property requirements, CAB-O-SIL® M-6KD and CAB-O-SIL® M-5KD fumed silicas clearly demonstrate advantages over 200 m²/g surface area precipitated silica.

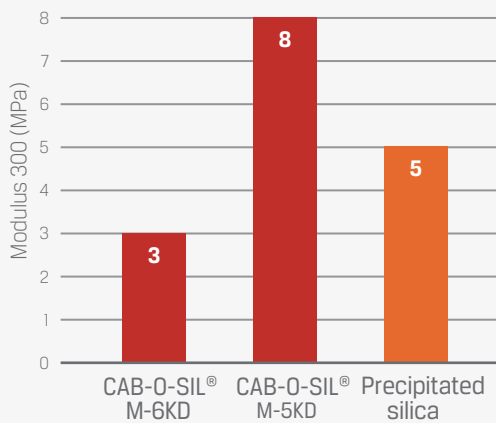
TENSILE STRENGTH



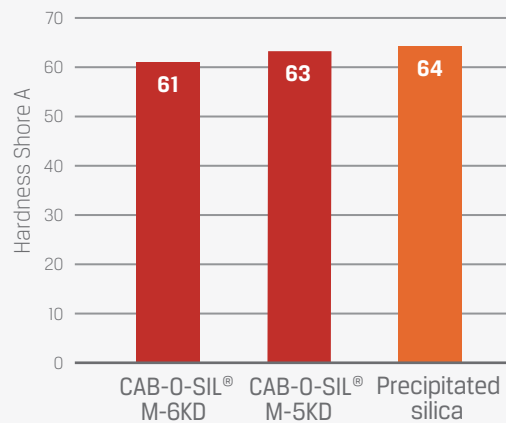
ELONGATION AT BREAK



MODULUS



HARDNESS



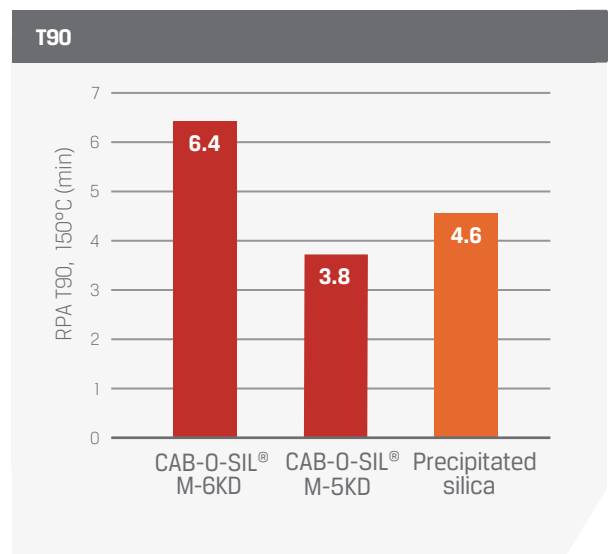
Processability

In the mixing process, fumed and precipitated silicas have comparable processability as measured by temperature and torque during the entire mixing process. With the peroxide curing agent used in this study, the BR/SBR/IR rubber compounds containing different silicas can be cured in a few minutes at 150°C, as tested in a Rubber Process Analyzer (RPA). These properties confirmed the good adaptability and processability of CAB-O-SIL® M-6KD and CAB-O-SIL® M-5KD fumed silica in a typical rubber goods manufacturing process.

Rubber Formulation

(phr)	1	2	3
BR	70	70	70
SBR	20	20	20
IR	10	10	10
M-6KD Fumed Silica	35	0	0
M-5KD Fumed Silica	0	35	0
Precip Silica	0	0	35
Peroxide	1	1	1
Process oil	10	10	10
Antioxidant	1	1	1

Please contact Cabot for detailed formulation and compounding process conditions.



At Cabot, we are committed to developing new technology innovations as we work to achieve our sustainability goals and optimize the performance of our customers' products by increasing the efficiency of their formulations.

For more information about the products and their application guidance, contact your Cabot representative or visit cabotcorp.com

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