善贞集团

SaneZen Group

High-dispersion multi-wall CNT for next-gen, high-performance tires

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进取**Enterprising** 高效**Efficient** 共赢**Win-Win**

-低碳科技 引领未来

Low-Carbon Technology: Pioneering a Sustainable Future

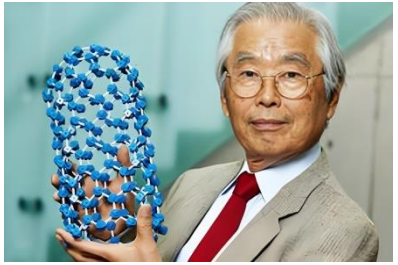
Introduction to Carbon Nanotubes

Carbon Nanotubes (CNTs) are tubular nanomaterials composed of carbon atoms, featuring a unique honeycomb-like graphite lattice structure. First discovered in 1991 by Japanese scientist Sumio Iijima, CNTs exhibit diameters at the nanoscale (typically 1–100 nm) while reaching lengths up to micrometers or even millimeters.Renowned as a revolutionary material in material science, CNTs possess:

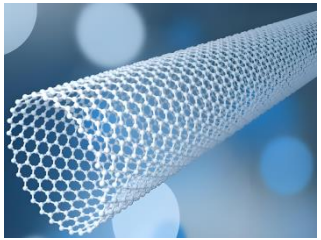
- Ultrahigh tensile strength (≈100× stronger than steel)
- Exceptional electrical conductivity (10,000× higher than copper)
- Remarkable thermal conductivity
- Extremely low density (≈1/6 that of steel)

Structurally, CNTs can be conceptualized as rolled graphene sheets.
Based on the number of concentric graphene layers, they are classified into:

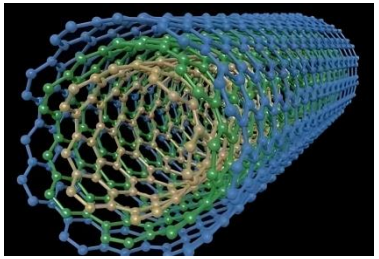
- Single-walled Carbon Nanotubes (SWCNTs)
- Multi-walled Carbon Nanotubes (MWCNTs)



Sumio Iijima饭岛澄男



单壁碳纳米管
Single Walled Carbon Nanotube



多壁碳纳米管
Multi-walled Carbon nanotube

玄珞碳纳米管CNT44G
Powerflex CNT44G

CNT44G carbon nanotubes: delivering high performance with everyday safety

Shanghai Powerflex New Material Co., Ltd. (a subsidiary of SaneZen Group) has developed the GreenThinking® CNT44G are vertically aligned carbon nanotube materials specifically engineered to enhance tire performance by reducing heat generation, improving mechanical properties, increasing abrasion resistance, and boosting thermal conductivity. These CNTs exhibit ultra-high tensile strength and Young's modulus, significantly reinforcing tire mechanical integrity to resist punctures and blowouts. Their nanostructure forms strong bonds with rubber matrices, enabling efficient stress distribution and preventing structural failure. Incorporation of CNTs also minimizes micro-cracks and defects within tires, extending service life through superior wear resistance. Additionally, their high thermal conductivity efficiently dissipates internal heat, preventing tire overheating.

Application in Tires:

GreenThinking® CNT44G deliver:

- Significantly enhanced tensile strength and tear resistance
- Improved abrasion and cut resistance
- Reduced operational heat buildup
- Optimized thermal management

These properties enhance tire stability, safety, and longevity across all segments, including passenger, commercial, and high-performance racing tires.

Key Performance Attributes:

- **Mechanical Reinforcement**:Exceptional tensile strength and modulus substantially improve tire structural integrity, ensuring stability and safety under heavy loads and high-speed conditions.
- **Heat Generation Reduction**:Minimizes hysteretic heat buildup by improving stress distribution, extending tire durability.
- **Abrasion Resistance Enhancement**:Reinforces tear/cut resistance and reduces wear, lowering replacement frequency and improving cost efficiency.
- **Thermal Conductivity Improvement**:Efficient heat dissipation prevents overheating, maintaining performance stability at elevated temperatures.
- **Rolling Resistance Reduction**:Low density and flexibility decrease rolling resistance, improving fuel efficiency and reducing emissions.

使用建议Usage Recommendations：

- 添加方式：CNT44G 一般在一段加入。
- 建议用量：3-6 Phr份，具体用量可根据实际工艺和性能需求进行调整

Addition Stage: Primary mixing (1st stage)
Dosage Recommendation: 3-6 phr (adjust based on processing requirements and performance targets).

Base Formulation

RM	A	B	C
	Blank	AF28	CNT44G
SCR 10	100	100	100
N234	31.3	31.3	22.8
ZnO	3	3	3
SA	3	3	3
Silica			9.6
Si69			0.8
AF28		1	
CNT44G			3.2
Total	137.3	138.3	142.4

Primary Masterbatch	137.3	138.3	142.4
N234	15.7	15.7	11.4
Wax	1	1	1
4020	1.2	1.2	1.2
RD	1	1	1
Total	156.2	157.2	157

Final Masterbatch	156.2	157.2	157
S	1.5	1.5	1.5
NS	1.1	1.1	1.1
Total	158.8	159.8	159.6

Mooney Viscosity & Curing Characteristics

Curing Condition: 151℃×40min

Product Code	151℃×40min	ML	MH	ts1	ts2	t10	t50	t90	Mooney
Blank	A	1.57	20.25	3.86	5.24	5.13	7.4	12.7	37.07
AF28	B	2.04	18.38	4.43	5	4.87	6.41	11.02	49.99
CNT44G	C	2.18	19.38	2.63	4.58	4.33	6.51	11.01	50.35

- **Conclution: CNT44G /** AF28 provides a little faster curing and high Mooney

Abrasion Resistance (DIN Method)

Curing Condition: 150℃×30min
Test Standard: ISO 23337
Test Parameters: Load 30N, Slip rate 10%, Speed 80m/min, Duration 3min

Product Code	DIN Abrasion	Average Abrasion	vs. Blank (%)
Blank	A	114.2	-
AF28	B	108.1	5.30%
CNT44G	C	115.6	-1.20%

➢ Conclution:

- **CNT44G:**Abrasion loss remains essentially unchanged at ≤3.2 phr loading, but decreases when CNT44G exceeds 3.2 phr.
- **AF28:**Improves abrasion resistance performance.

Basic Properties (Before Aging)

Curing Condition: 151℃×30min

Product Code	Shore A Hardness	Specific Gravity	Scorch Time (min)	Tensile Strength (MPa)	Elongation at Break (%)	Modulus 100% (MPa)	Modulus 200% (MPa)	Modulus 300% (MPa)	Modulus 400% (MPa)	Modulus 500% (MPa)
Blank	66	1.101	26.78	25.83	471.67	2.76	7.3	13.87	21	-
AF28	65	1.105	22.98	26.13	471.66	2.83	7.29	14.04	21.28	-
CNT44G	64	1.105	22.62	25.86	516.26	2.98	7.38	14.68	21.43	23.00

➢ **Conclution:**

- CNT44G & AF28: Both show corresponding improvements in tensile strength, elongation, and modulus.

Compression Heat Build-Up

Curing Condition: 151℃×30min
Test Parameters: Initial temp. 55℃, Stroke 4.45mm, Recovery speed 10mm/min, Test duration 25min

Product Code	Compression Heat Data (℃)	Final Temp. Rise (℃)			Average	vs. Blank (%)
Blank	A	7.7	5.3	5.1	6.03	-
AF-28	B	3.8	4.7	4.2	4.23	-29.80%
CNT44G	C	8.9	8.0	7.3	8.07	33.80%

➢ Conclution:

- **CNT44G** exhibits higher compression heat buildup under constant strain mode but demonstrates an advantage in elastic modulus under constant stress mode (which better represents actual vehicle driving conditions).
- **AF28** achieves approximately 30% lower compression heat buildup under constant strain mode.

DMA Results DMA data

Curing Condition: 151℃×30min

Product Code	DMA Results	DMA tan0℃	vs. Blank (%)	tan δ @ 60℃	vs. Blank (%)
Blank	A	0.2088	-	0.148	-
AF28	B	0.2284	9.40%	0.1222	-13.2%
CNT44G	C	0.2208	5.70%	0.1619	15.0%

➢ **Conclution:**

- Both CNT44G and AF28 show significant improvements in wet grip.
- While CNT44G shows increased rolling resistance, AF28 reduces rolling resistance by 13.2%.

Tear Strength

Curing Condition: 151℃×30min (Right-angle tear)

Product Code	Right-Angle Tear	Tear Strength (N/mm)	vs. Blank (%)
Blank	A	77.04	-
AF28	B	95.35	23.77%
CNT44G	C	101.96	24.45%

➢ **Conclution:**

- Angle tear strength is substantially increased for both CNT44G and AF28, by 28.1% and 24.3% respectively.

Thermal Conductivity

Curing Condition: 151℃×30min
Test Parameters: 300K, 1.5V, 1s acquisition

Product Code	Thermal Conductivity	Data 1	Data 2	Data 3	Average	vs. Blank (%)
Blank	A	0.2344	0.2441	0.246	0.2415	-
AF28	B	0.2455	0.248	0.2464	0.2466	2.10%
CNT44G	C	0.2671	0.2669	0.2668	0.2669	10.50%

➢ **Conclution:**

- Thermal conductivity is enhanced for both compounds: CNT44G by 10.5% and AF28 by 2.1%.

Looking Forward to Cooperate

共赢精进！

Better Together