

ZL-PAD Series Foot Pads

for Quadruped Robot Dogs

Cushioning

Anti-slip

Wear Resistance

Quiet Operation



Quadruped robot dog



ZL-PAD foot pad



Field-proven durability

1. Robot Dog — Foot Components



Unitree B2 quadruped robot



Foot pad (front view)



Foot pad wear in the field



Tread pattern of the foot pad

★ **Foot pad functions:** cushioning & shock absorption, enhanced grip

★ **Role of the foot pads:** mitigate impact loads, increase friction, quiet operation and protection

★ **Current problems:** high load with heavy impact, poor wear resistance, easy slipping

2. Mainstream Material Options

▲ Nitrile Rubber (NBR)

Excellent wear and oil resistance; adapts well to rough ground or oily industrial environments. Drawback: it tends to harden and become brittle at low temperatures, which reduces grip.

▲ Silicone Rubber (Q)

Good flexibility and a wide operating temperature range ($-50\text{ }^{\circ}\text{C}$ to $200\text{ }^{\circ}\text{C}$); extremely low ground-contact noise, suitable for quiet environments such as homes and laboratories. Drawback: relatively poor wear resistance; not suitable for long-term use on rough pavement.

▲ Polyurethane Rubber (PU)

Strong overall mechanical properties; wear and tear resistance far superior to ordinary rubber, with outstanding cushioning and shock absorption. Suitable for robot dogs on complex outdoor terrain or requiring frequent jumping. Drawback: poor hydrolysis resistance and UV resistance, and slightly inferior low-temperature flexibility.

▲ Natural Rubber (NR)

Excellent elasticity and outstanding grip; suitable for dry, flat indoor floors. Drawback: poor aging and oil resistance; tends to age and crack after long-term exposure to sunlight or oily environments.

3. Akron Abrasion Comparison

Table 1 Reference Akron abrasion of common rubbers

Rubber type	Akron abrasion (cm ³ /1.61 km)
NBR	0.1–0.2
Q (silicone)	0.5–0.8
PU	0.03–0.1
NR	0.2–0.3

Table 2 Measured Akron abrasion of samples

Rubber type	Akron abrasion (cm ³ /1.61 km)
Rubber 50#	0.29
Rubber 60#	0.12
ZL-PAD-70A	0.03
TPU sample	0.05



Akron abrasion tester (GB/T 1689)

Test equipment: Akron abrasion tester, per GB/T 1689. — **ZL-PAD-70A: lowest abrasion loss.**

4. Wet-Slip Resistance Comparison

No.	Rubber type	0 °C tan δ	Actual temperature point (°C)	Remarks
1	TPU sample	0.258	0.09	
2	ZL-PAD-70A	0.536 / 0.7	0.12	☆☆☆
3	BH-M-NR70	0.137	0.11	

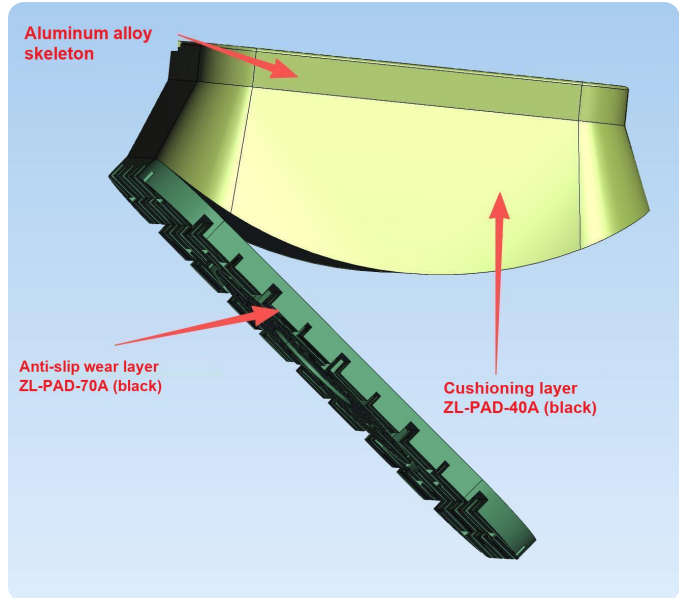
Test equipment: DMA. — **A higher 0 °C tan δ value indicates better wet-slip performance.**

Test conditions: with reference to the 0 °C tan δ test used for tire-tread wet-slip evaluation, the core conditions are defined by three key parameters — frequency, strain, and heating rate. The standard and preferred practical conditions are: **10 Hz, tensile mode, 0.3% strain, heating rate 3 °C/min, range –40 °C to 80 °C.**

- **Frequency:** fixed at 10 Hz — simulates the dynamic loading state of tread rubber at medium vehicle speed; the industry-standard frequency for wet-slip evaluation (recommended by ISO 4664-2 and ASTM D5992).
- **Strain / stress:** small-strain mode — 0.1%–0.5% dynamic strain in tensile mode, or shear strain below 5×10^{-4} in shear mode, to keep the test within the linear viscoelastic range.
- **Temperature & heating rate:** target temperature 0 °C; if a temperature sweep is used for auxiliary verification, the heating rate is set to 2–3 °C/min over a range of –40 °C to 80 °C.

5. Material Selection Recommendation

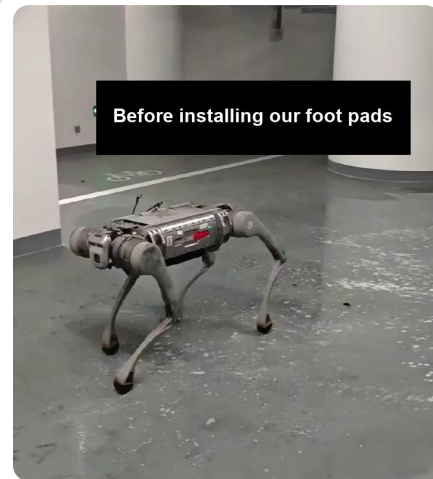
Middle: ZL-PAD-40A (cushioning) · Bottom: ZL-PAD-70A (damping & anti-slip)



Foot pad cross-section: aluminum alloy skeleton (top), cushioning layer ZL-PAD-40A, wear-resistant anti-slip layer ZL-PAD-70A



ZL-PAD foot pad product



Field test before installing our foot pads

6. Typical Product Performance

Table 3 Typical performance of ZL-PAD-40A (black)

Property	Unit	Typical value	Test standard
Color	/	Black	Visual
Base material	/	Modified rubber	/
Density	g/cm ³	1.2 ± 0.1	GB/T 533
Hardness	Shore A	40 ± 5	GB/T 39693.4
Tensile strength	MPa	8	GB/T 528
Elongation at break	%	500	GB/T 528
Compression set, 70 °C × 24 h, type A, 25%	%	20	GB/T 7759
Loss factor tan δ max	/	1.2	GB/T 9870.1
Temp. range of tan δ > 0.6	°C	-25 to 36	GB/T 9870.1
Temp. range of tan δ > 0.4	°C	-50 to 48	GB/T 9870.1
Temp. range of tan δ > 0.3	°C	-50 to 55	GB/T 9870.1
Recommended temperature range	°C	-45 to 140	/

Table 4 Typical performance of ZL-PAD-70A (black)

Property	Unit	Typical value	Test standard
Color	/	Black	Visual
Base material	/	Modified rubber	/
Density	g/cm ³	1.2 ± 0.1	GB/T 533
Hardness	Shore A	70 ± 5	GB/T 39693.4
Tensile strength (min)	MPa	10	GB/T 528
Elongation at break (min)	%	300	GB/T 528
Compression set, 70 °C × 24 h, type A, 25%	%	15	GB/T 7759
Loss factor tan δ max	/	0.72	GB/T 9870.1
tan δ at 0 °C	/	0.70	GB/T 9870.1
Temp. range of tan δ > 0.4	°C	-35 to 32	GB/T 9870.1
Temp. range of tan δ > 0.3	°C	-50 to 48	GB/T 9870.1
Recommended temperature range	°C	-45 to 140	/

Notes: all data are typical laboratory test values; test-sheet vulcanization: 170 °C × 20 min, 10 MPa; DMA test conditions: 10 Hz, tensile mode, 0.3% elongation, heating rate 3 °C/min.

7. DMA Temperature Sweep Curves

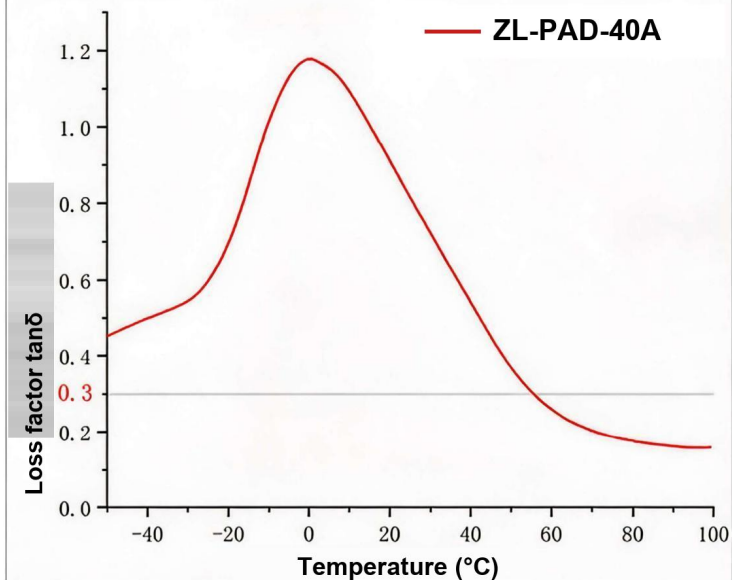


Fig. 1 Temperature sweep curve

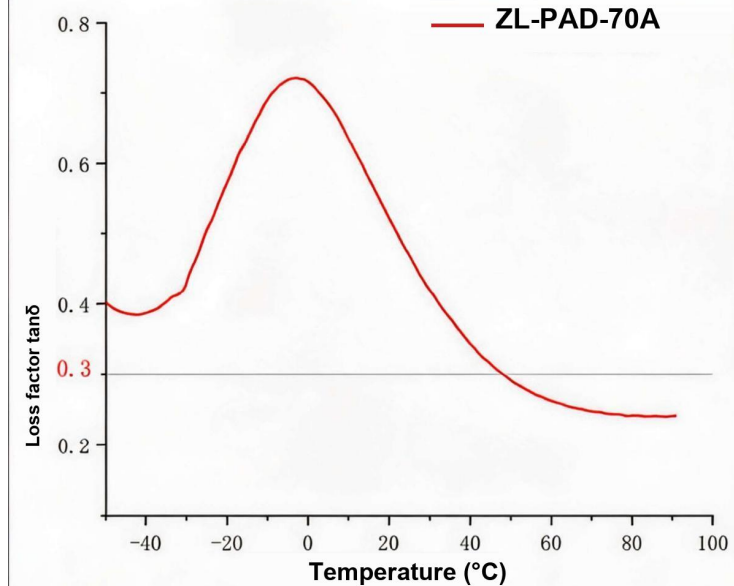


Fig. 2 Temperature sweep curve

Thank You!

Shenzhen Intelligent ShoeTech Co., Ltd.

Professional robot dog foot pad solutions — cushioning, anti-slip, wear resistance, quiet operation

Contact us for samples, customization and field-trial support.