SAVROC

TripleHard®

NEXT-GENERATION TRIVALENT HARD CHROME TECHNOLOGY

NEXT-GEN PERFORMANCE FOR SHOCK ABSORBERS

For over a decade, Savroc has developed advanced trivalent chromium coatings to meet the growing demand for safer and more sustainable surface technologies. TripleHard® is the latest result of this development — a high-performance trivalent hard chrome coating for shock absorber rods in the most demanding industrial and mobile machinery environments.

Combining hardness, wear resistance, corrosion protection and low-friction operation with a smooth, uniform surface, TripleHard® delivers the proven durability of hard chrome without the environmental and safety concerns of hexavalent chromium.

Built for demanding applications

Shock absorbers in heavy-duty vehicles and industrial machinery operate in harsh environments – exposed to abrasive dust, mud, moisture, corrosive conditions and repetitive impact. TripleHard® has been developed specifically to protect shock absorber rods under these extreme loads. The dense, crack-tolerant coating resists wear, corrosion and microcracking while maintaining surface smoothness critical for seal performance. It also withstands high cycling frequencies and constant seal contact without loss of damping behavior.

The structure and hardness of the coating remain stable across wide temperature ranges, ensuring consistent damping performance and lower friction, even in continuous operation in mining, transport, and off-road applications. The result: longer service life, less maintenance and smoother suspension operation.

Low friction for seals and smooth operation

TripleHard® provides a hard, low-friction surface that works together with modern seal materials. The smooth, uniform finish supports stable seal contact pressure, minimizing stick–slip and helping to keep damping behaviour predictable even in harsh conditions.

Reduced friction also lowers rod and seal wear and helps control oil temperature, contributing to longer seal life and more consistent suspension performance over long service intervals.

Engineered precision in every layer

TripleHard® combines the well-known hardness and mirror-like finish of traditional hard chrome with the uniformity and control of a modern trivalent chromium process. The coating is applied using optimized plating parameters that balance current density, temperature and bath chemistry to achieve a dense, fine-grained microstructure.

Each layer is deposited and finished under tightly monitored conditions to ensure excellent adhesion to the base steel, low surface roughness and a defect-free coating. The process allows precise control of coating thickness and guarantees that every rod can be ground, polished and integrated into assemblies just like conventionally coated components.

Sustainable surface technology

Savroc's long-term goal is to make this trivalent technology the new industry standard for high-performance chrome coatings – replacing toxic legacy processes with safer, REACH-compliant solutions.

TripleHard® contains no hexavalent chromium and complies fully with REACH and environmental safety regulations. It enables the substitution of a known carcinogen with a responsible, future-proof alternative – exactly what industries and regulators expect when viable options exist.

Compared to traditional hard chrome, TripleHard dramatically improves EHS performance: reduced worker exposure, easier ventilation, simplified permitting and lower waste handling. It's a step change in sustainability – without compromising technical performance.

Consistent quality, proven results

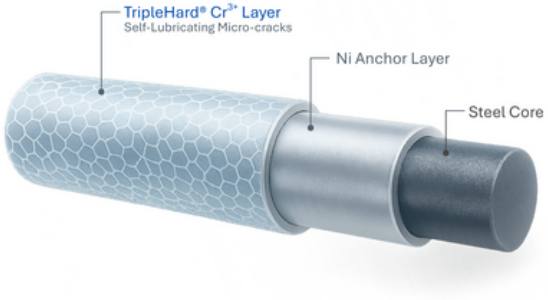
Savroc's production follows standardized quality procedures designed for industrial scalability. Every batch is inspected for hardness, thickness, adhesion, uniformity and corrosion protection according to ISO 9227, ISO 4287 and ASTM G65.

These systematic controls ensure reliable coating behavior from prototype to full production. The coating has been validated in industrial applications, demonstrating excellent seal compatibility, low wear and extended operational durability. Partners can rely on consistent performance throughout the lifecycle of every component, from first assembly to long-term shock absorber operation in the field.

TECHNICAL PERFORMANCE & COMPARATIVE ADVANTAGES

Savroc's TripleHard® coating is designed for the extreme conditions that shock absorber rods face in heavy-duty vehicles, mining equipment and industrial machinery.

It delivers the performance of conventional hard chrome – with better wear resistance, higher corrosion protection and lower friction – **all in a Cr(VI)-free, REACH-compliant process.**



High-Speed Deposition for Productivity

TripleHard® offers a high plating rate of ~4 µm/min, enabling ~20 µm coating in just 5 minutes. Compared to traditional hard chrome (typically ~0.5 µm/min), this significantly reduces cycle times and supports high-volume rod production. Retrofits using open tanks have demonstrated up to 42% increase in rod throughput versus legacy Cr(VI) lines.

Superior Surface Hardness

The as-plated hardness of TripleHard® ranges from 1,000 to 1,500 HV, with microhardness measurements reaching up to 1,800 HV (HV0.1). This high hardness improves wear resistance and protects against rod scratching, impact and abrasive particles — extending shock absorber service life and reducing seal damage.

Adhesion & Mechanical Robustness

TripleHard® forms a dense, crack-free coating with exceptional adhesion to the base steel. The coating has passed 180° bend, scratch and impact tests without cracking or flaking. It withstands side loads, flexing and high-frequency suspension cycles without risk of coating detachment.

Friction & Seal Compatibility

The low-friction surface (~0.15 µ) minimizes stick-slip and seal wear. TripleHard® ensures smooth rod movement and predictable damping behavior over long intervals. It supports extended seal life and consistent shock absorber performance, even under harsh road conditions.

Corrosion Resistance

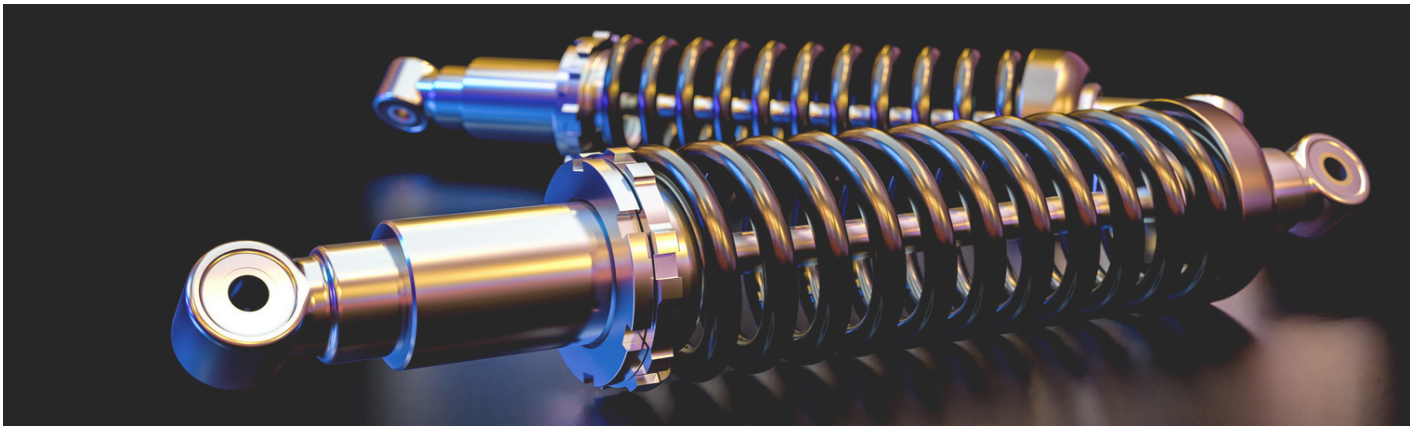
TripleHard® uses a microcrack-free trivalent chromium layer with a nickel underlayer, providing excellent corrosion protection. In ISO 9227 neutral salt spray testing, coated rods maintained rating 10 (no base corrosion) beyond 1,000 hours — outperforming conventional Cr(VI) coatings.

Test condition	Coating thickness	Surface hardness ($HV_{0.05}$)	Surface roughness (Ra)
200 h NSS - TripleHard®	30 µm	1,000 - 1,300 HV	< 0.2 µm
500 h NSS - TripleHard®	40 µm	1,000 - 1,300 HV	< 0.2 µm
1,000 h NSS - TripleHard®	50 µm	1,000 - 1,300 HV	< 0.2 µm

TripleHard® vs. conventional hard chrome

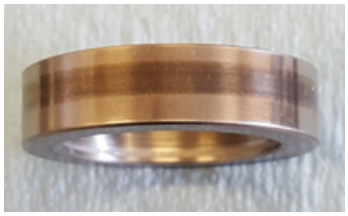
Property	TripleHard®	Cr(VI) Hard Chrome
Plating speed	~4 µm/min	~0.5 µm/min
Surface Hardness	1,000-1,500 HV	800-1,000 HV
Friction Coefficient	~0.15	~0.25
Corrosion Resistance	Excellent	Moderate
CO_2 emissions	Low	High
Adhesion & Ductility	Passes 180° bend, no flaking	Brittle, risk of microcrack flaking

TripleHard® matches or exceeds the key performance metrics of hard chrome while eliminating Cr(VI) and simplifying compliance. It combines speed, durability and environmental responsibility in a drop-in solution for modern rod plating lines.



TRIPLEHARD WEAR RESISTANCE TESTS

Block on Ring test

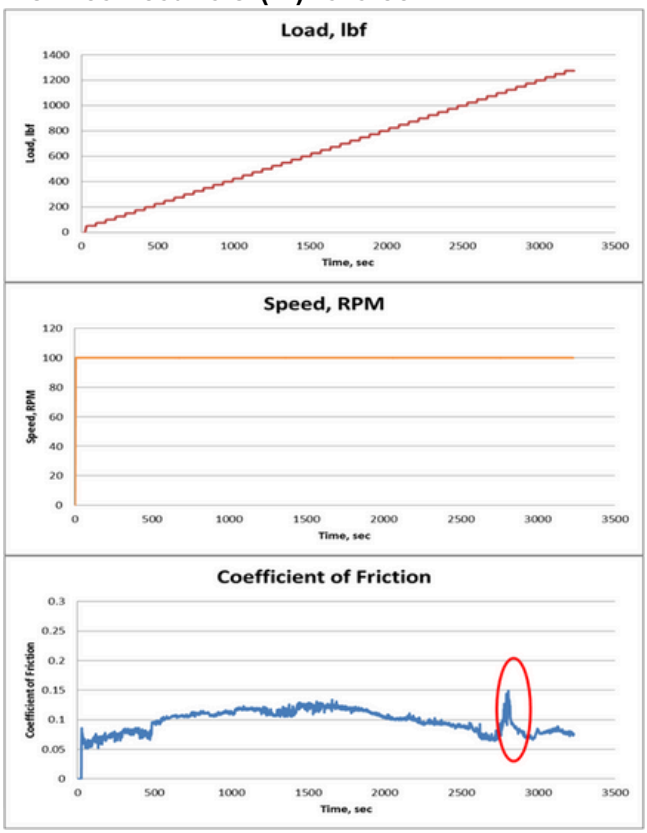


In an independent Block-on-Ring (BOR) wear test conducted by a third-party laboratory, TripleHard® clearly outperformed conventional Cr(VI) hard chrome under extreme mechanical stress.

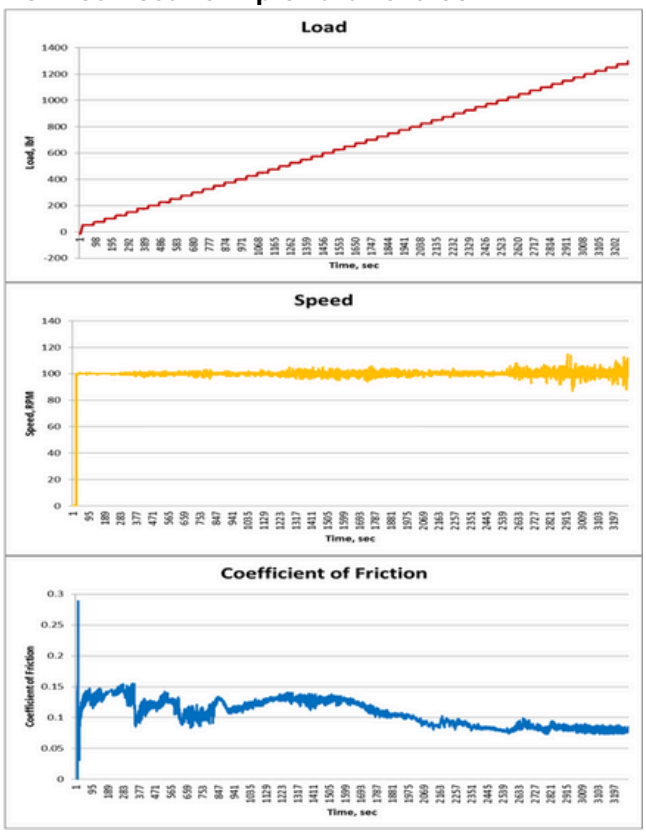
The test ran continuously for 3,200 seconds (over 53 minutes) with increasing load. Cr(VI) coatings failed prematurely at a load of **1,100 lbf** (~50.8 MPa contact pressure), showing friction spikes and visible surface damage. In contrast, the TripleHard® layer withstood the maximum test load of **1,275 lbf**, enduring a peak contact pressure of **850 MPa**, and completed the full test cycle without surface breakdown.

This confirms TripleHard's superior resistance to sliding wear and mechanical impact – especially relevant for shock absorber rods operating under side loads, vibrations and contamination in heavy-duty and off-highway applications.

BOR test results Cr(VI) vs. steel

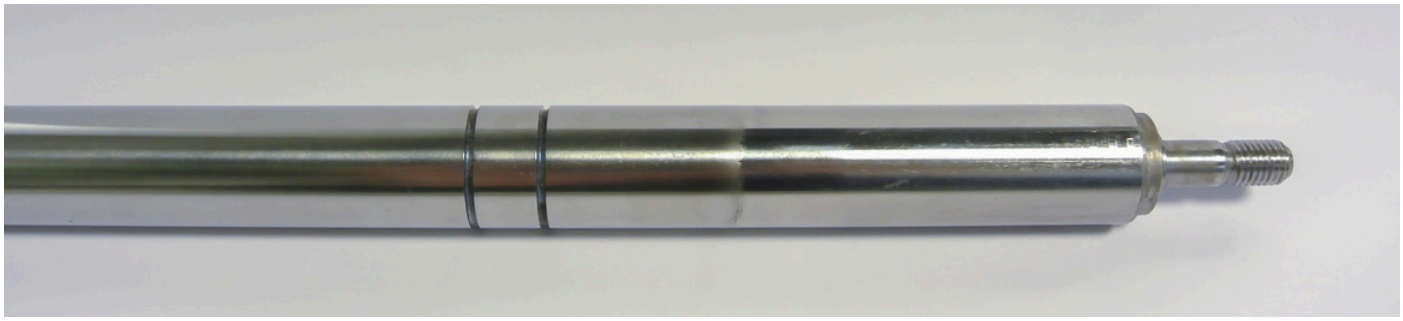


BOR test results TripleHard vs. steel



Abrasive wear vs. Cr(VI)

In an independent Taber abrasion test, TripleHard® showed **~50% less** material loss compared to standard Cr(VI) coatings. Using CS-10 wheels and 1,000 cycles at 1 kg load, the TripleHard layer retained its surface integrity much better, achieving a wear index of **1.03 mg** – compared to **2.0 mg** for Cr(VI). For shock absorber rods operating in dusty or abrasive conditions, this translates into smoother rods for longer, extended seal life, and fewer replacements due to surface scratches or pitting.



HOW TO INTEGRATE TRIPLEHARD INTO YOUR COATING PRODUCTION

Retrofit-ready for shock absorber rod lines

TripleHard® is designed to be integrated into existing shock absorber rod coating operations as a drop-in replacement for conventional hard chrome. The duplex nickel + trivalent chrome process runs on standard electroplating infrastructure, so your current tanks, power supplies, handling and automation can largely be reused with targeted modifications.

Open-tank retrofit for conventional Cr(VI) lines

Existing open-tank hard chrome lines can be converted to TripleHard® with focused changes in the plating section rather than a complete rebuild. Typical retrofit actions include:

- Replacing the Cr(VI) bath with Savroc's trivalent chrome chemistry
- Introducing a nickel underlayer stage where needed
- Adjusting process parameters to Savroc's validated TripleHard® settings

These modifications are typically a smaller investment than upgrading Cr(VI) lines to meet tightening regulatory requirements, such as additional fume extraction, waste treatment and permitting for hexavalent chrome. At the same time, line capacity and cycle times benefit from TripleHard's high deposition rate.

Integrated line retrofit for cassette / carrier systems

Many shock absorber manufacturers use automated cassette, shuttle or carrier-based plating lines. TripleHard® can be implemented in these systems by converting the existing chrome cell to trivalent chemistry and adding a nickel stage into the carrier sequence.

The automation, carriers and handling logic remain in place; only the process modules and recipes change. This keeps disruption low while enabling a Cr(VI)-free, high-throughput coating cell tailored for shock absorber rods.

Phased transition

Both retrofit paths support a gradual, low-risk rollout. Production can start by coating a selected shock absorber program or diameter range with TripleHard®, while other products continue on legacy lines.

As confidence grows, more references can be moved over, and open-tank and integrated TripleHard® lines can operate in parallel. This phased approach helps manage capacity, training and customer approvals, while steadily reducing dependence on hexavalent chrome.

Seamless downstream processing

After plating, TripleHard®-coated rods follow the same downstream steps as conventional chrome: grinding (if required), polishing and final inspection on existing equipment.

The uniform, adherent coating maintains tight diameter tolerances and surface finish needed for seal performance and NVH, and it tolerates re-polishing during service without flaking. Integration effort stays concentrated in the plating section, while machining, finishing and assembly can continue unchanged.

Easy start-up with Savroc support

Savroc offers a **no-pilot-required** start-up route: customers can move directly into production using pre-qualified bath chemistry and process windows that have been proven in industrial use. For plants that prefer extra validation, pilot runs can be arranged either at Savroc or on-site.

In both cases, Savroc provides process design, commissioning support and operator training. This ensures a smooth ramp-up, from first bath fill and parameter tuning to routine quality control and audit preparation.

Retrofit your existing line >>> **License, training & audit** >>> **Ramp-up & Cr(VI) phase-out**

PROVEN PERFORMANCE. READY TO DEPLOY.

TripleHard® is a trivalent Ni+Cr coating that pairs hard-chrome-class performance with modern EHS compliance. Built for shock absorber rods in demanding suspension applications.

Spec highlights

- **Coating:** Nickel underlayer + Cr(III) top layer
- **Hardness:** 1,000-1,500 HV
- **Surface roughness:** < 0.2 µm
- **Corrosion:** 200h / 500h / 1,000h → Rating 10
- **Friction & wear:** µ = 0.15–0.20; 100 % BOR pass
- **Repairability:** Strip + re-coat; full refurbishment

Test methods & compliance

ISO 9227 (NSS)

ISO 10289 (corrosion evaluation)

ISO 4287 (Surface roughness Ra)

Cr(VI)-free & REACH-compliant

Supports EU substitution expectations

Improves EHS: Lower exposure, simpler ventilation & waste handling, reduced audit risk

Request trial rods · Book a corrosion/wear evaluation · Get detailed test reports

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