

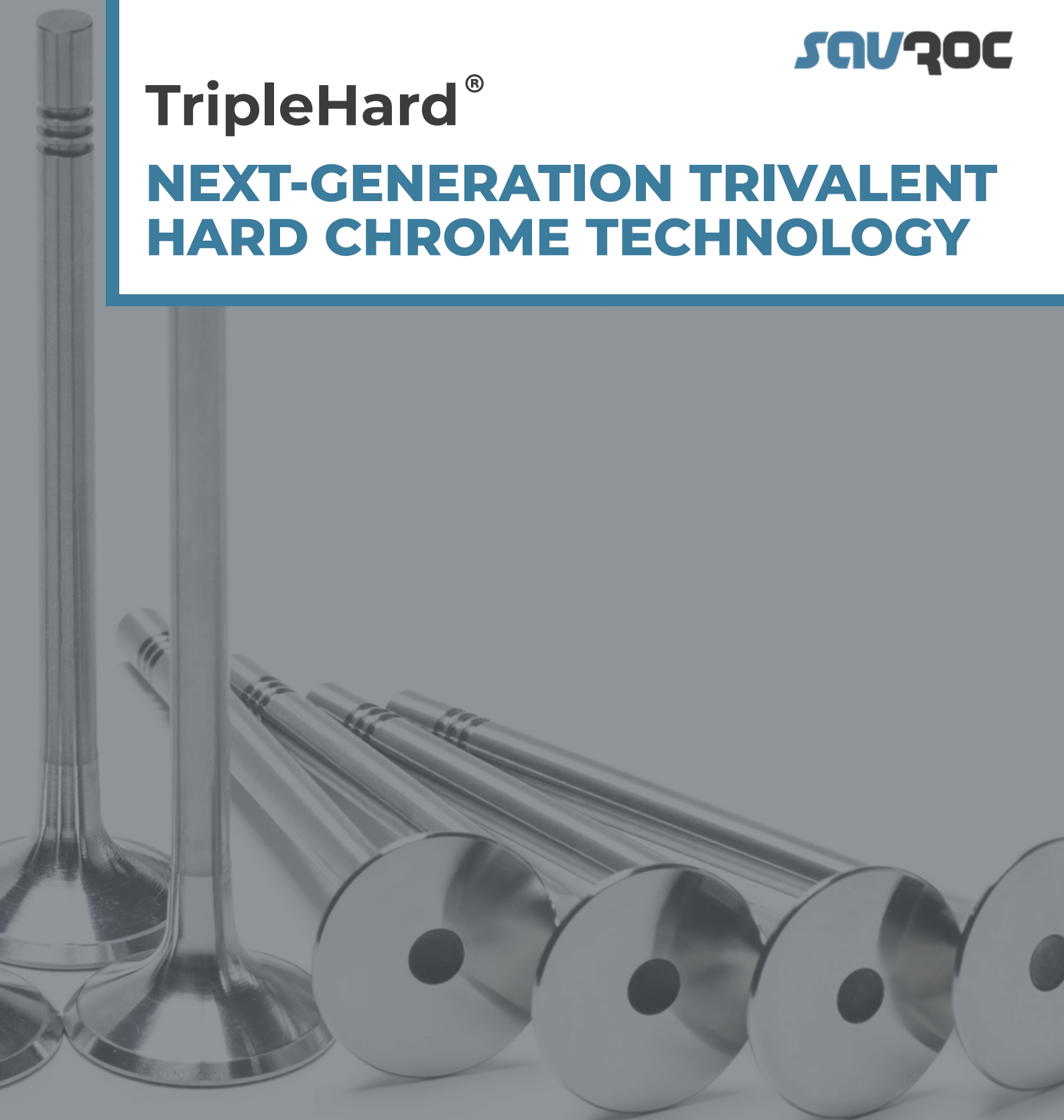


SAVROC



TripleHard[®]

**NEXT-GENERATION TRIVALENT
HARD CHROME TECHNOLOGY**



NEXT-GEN PERFORMANCE FOR ENGINE COMPONENTS

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 engine valves in demanding environments.

Combining hardness, wear resistance, corrosion and heat protection with a smooth, uniform surface, TripleHard® delivers the proven durability of hard chrome in a Cr(III) hard-chrome process.

Built for the harshest engine conditions

Engine valves operate in extreme conditions – high temperatures, continuous impact on the valve seat, and abrasive gas flows. TripleHard® has been developed to protect valve surfaces against wear, corrosion, and microcracking under these severe loads. The coating's structure and hardness remain stable even at elevated temperatures, ensuring long-lasting protection for both intake and exhaust valves — resulting in reduced wear, fewer maintenance interventions, and more reliable engine operation.

Sustainable surface technology

TripleHard® is made in a Cr(III) hard-chrome process, in place of hexavalent chromium chemistry. It enables direct substitution of a known carcinogenic process with a proven alternative — exactly what regulators expect when viable options exist.

Conventional hard chrome imposes heavy EHS burdens: toxic-mist control, exposure monitoring, and hazardous-waste handling. TripleHard®'s trivalent nickel-chrome system reduces worker exposure, simplifies ventilation and waste management, and de-risks audits — without compromising component performance. Savroc's long-term goal is to make this trivalent technology the industrial standard for engine valve coatings and other demanding engine components.

Typical applications

TripleHard® coated valves are suited for a wide range of engine applications:

- Intake and exhaust valves in heavy-duty diesel and gas engines
- Valves in off-highway, marine and industrial engines
- Other reciprocating engine components requiring a hard, low friction-surface

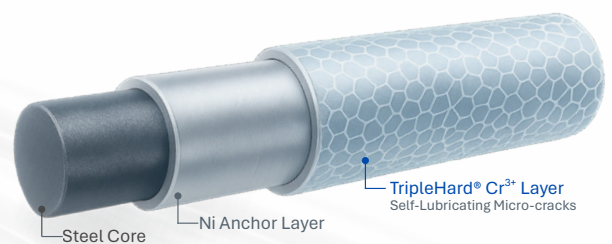
The coating is compatible with typical heat-resistant valve steels and, with proper pre-treatment, also with stainless and alloyed valve grades.

Engineered precision in every layer

TripleHard® combines the hardness and mirror-like finish of traditional hard chrome with the uniformity of a modern trivalent chromium process. Applied using optimized plating parameters that balance current density, temperature and bath chemistry, the coating achieves a dense, fine-grained microstructure with excellent adhesion, low surface roughness and a defect-free finish. Every valve can be ground, polished and integrated into assemblies just like conventionally coated components.

Coating composition

TripleHard® consists of a dual-layer system: a nickel underlayer that enhances corrosion protection and adhesion, topped by a trivalent chromium layer that provides surface hardness, wear resistance and the bright metallic appearance expected from high-quality engine components.



Consistent quality, proven results

The TripleHard® process is specified with standardized quality procedures designed for industrial scalability: hardness, thickness uniformity, adhesion and corrosion resistance are verified according to ISO 9227, ISO 4287 and ASTM G65 test methods — ensuring repeatable performance from sample batches to full production lines.

Test condition	Coating thickness	Surface hardness (HV _{0.05})	Surface roughness (Ra)
250 h NSS - TripleHard®	30 µm	900–1050 HV	< 0.2 µm
500 h NSS - TripleHard®	40 µm	900–1050 HV	< 0.2 µm
1000 h NSS - TripleHard®	50 µm	900–1050 HV	< 0.2 µm

DURABILITY IN EXTREME ENGINE CONDITIONS

Engine valves operate in an extremely demanding environment – continuous heat, friction, impact loads and corrosive combustion gases. Laboratory tests show TripleHard® resisting wear, heat and acid better than conventional hard chrome, in a Cr(III) hard-chrome process.

Wear resistance and reduced friction

TripleHard® forms a hard, uniform surface that resists sliding wear between the valve stem and guide. In a sliding wear test, a 40 µm TripleHard® layer kept a surface roughness of Ra 0.3 µm up to 20 MPa contact pressure after 600 cycles, where 80 µm Cr(VI) hard chrome roughened to Ra 1.75 µm. Its low-friction surface lightens valve movement and reduces guide wear.

Heat and corrosion resistance

TripleHard® maintains its structure and hardness at extreme temperatures, withstanding more than 500 °C without softening, and its hardness rises after heat cycling to 500 °C. This is critical for exhaust valves exposed to constant thermal loads and rapid cycling. TripleHard® also offers excellent acid resistance: no measurable attack in 5 % H₂SO₄ at 100 °C, protecting valves from aggressive condensates and combustion residues over long service intervals.

Repairability and lifecycle cost

TripleHard® coated valves can be refurbished instead of scrapped. The coating can be polished off, the surface re-prepared and re-coated without altering base material dimensions or mechanical properties, even after exposure to aggressive environments. This enables full component rebuilds, reducing downtime, waste and total lifecycle cost.

TripleHard® vs. conventional hard chrome

Feature	TripleHard®	Cr(VI) Hard Chrome
Hardness (HV)	900 - 1050	800 - 1,000
Acid 5% H ₂ SO ₄ at 100 °C	0 µm in 23 min	7–22 µm in 2–22 min
Corrosion resistance	Excellent	Moderate
Coating thickness on the stem (µm)	5–10	5–200
Heat resistance	>500 °C without softening; harder after heat cycling to 500 °C	~400 °C and softens at elevated temperature

HOW TO INTEGRATE TRIPLEHARD INTO YOUR COATING PRODUCTION

TripleHard® integrates into existing engine valve coating lines as a drop-in replacement for conventional hard chrome. The process uses a duplex nickel-plus-chrome structure and operates with standard electroplating infrastructure — existing tanks, power supplies and racking systems remain largely usable.

Drop-in retrofit — minimal changes, real savings

An existing line is converted: the Cr(VI) bath is replaced with a TripleHard® Cr(III) bath, a nickel bath is added where the line has none, and the anodes change. Most of the infrastructure carries over. Converting is often a lower investment than upgrading a Cr(VI) line to meet tightening regulation

Environmental and compliance benefits

TripleHard® is a Cr(III) hard-chrome process with no boric acid in the bath and many times less chromium than a Cr(VI) bath — simplifying wastewater treatment, fume extraction, workplace safety and audit processes.

Phased transition and easy start

Customers can begin by coating a single valve series while continuing other products on legacy lines, gradually shifting production over time. Savroc offers a no-pilot startup path using pre-qualified bath chemistry and parameters, with full technical support and operator training throughout ramp-up.

Seamless downstream processing

After plating, valves follow the same finishing steps as conventional chrome — grinding, lapping and polishing on existing equipment. The coating maintains tight dimensional tolerances and supports re-grinding in service without damage.

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



PROVEN PERFORMANCE. READY FOR QUALIFICATION.

TripleHard® is a trivalent Ni+Cr coating that pairs hard-chrome-class performance with modern EHS compliance. Built for engine valves in demanding conditions.

Spec highlights

- **Coating:** Nickel underlayer + Cr(III) top layer
- **Hardness:** 900–1050 HV
- **Surface roughness:** < 0.2 µm
- **Heat resistance:** >500 °C, no softening
- **Acid resistance:** 5% H₂SO₄ at 100 °C – no mass loss
- **Sliding wear:** Ra 0.3 µm at 20 MPa after 600 cycles (40 µm)
- **Repairability:** Strip + re-coat; full refurbishment

Test methods & compliance

ISO 9227 (NSS)

ISO 10289 (corrosion evaluation)

ISO 4287 (Surface roughness Ra)

Cr(III) hard-chrome process

Supports EU substitution expectations

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

Send us your drawings • Visit the line in Kuopio • Get detailed test reports

Contact — Savroc

Jussi Räisä

✉ jussi.raisa@savroc.com

☎ +358 443071409

📍 Varikkokatu 2, 70620, Kuopio, Finland

🌐 [Savroc.com](https://savroc.com)



Savroc Oy

Varikkokatu 2, 70620, Kuopio, Finland

Email: jussi.raisa@savroc.com

Phone: +358 44 307 1409

savroc.com