stryker

Triathlon® Gold

Technology guide

Trust beyond the surface.

Built on the legacy.

Triathlon Gold represents the next evolution in total knee replacement, an option for patients with metal sensitivity and/or bone cement (PMMA) allergy concerns. As an alternative to cobalt chrome (CoCr) femoral components, **Triathlon Gold combines the clinically trusted Triathlon CR design[1-6] with an additively manufactured titanium substrate and biocompatible titanium nitride (TiN) coating.[7]** It is designed to deliver fixation[8] and long-term durability[9] with scratch resistance superior to competitive surfaces.[10]

Built on the legacy of the trusted **Triathlon CR design,** which has a clinical history of delivering **stability,[11] satisfaction[1] and survivorship[1]** in total knee arthroplasty.

Triathlon Gold's TiN coating was designed with performance in mind to deliver **scratch resistance** superior to competitive offerings.[10]

Highly porous, additively-manufactured Tritanium® fixation technology, with a **history of clinical success** across multiple Stryker implants, including the Triathlon Cementless Baseplate,[4] Triathlon Patella[12] and Metaphyseal Cones.[13]

Dual-indicated for **cemented or cementless use** and compatible with the Mako Total Knee application and Triathlon manual instrumentation.

Combine your preferred fixation method and workflow with Triathlon Gold for **trust beyond the surface.**

Mako SmartRobotics™ has been used to implant **over 1.5 million Triathlon knees.[14]**

The unique features of Mako SmartRobotics™ and the powerful combination with Triathlon are designed to help surgeons achieve Functional Knee Positioning™ through 3D CT-based implant planning, dynamic joint balancing and AccuStop™ haptic technology. Mako Total Knee allows you to know more about your patient, so you can cut less.* [15, 16]

Trust beyond the surface.

What is TiN?

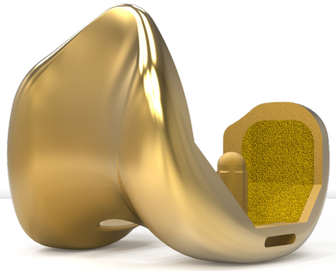
Titanium Nitride (TiN) is a ceramic coating used clinically on orthopedic implants since the 1990s.[17, 18] TiN-coated hip and knee implants have been used in patients with metal sensitivity concerns,[19, 20] with retrieval analyses and clinical cohort studies demonstrating reliable performance.[19, 20] Preclinical studies have reported that TiN coatings can provide high surface hardness[21, 22] and scratch resistance.[22, 23] Additionally, under laboratory tribological test conditions they have exhibited reduced coefficients of friction,[24] decreased polyethylene wear,[24,25] increased abrasive wear resistance[26] and corrosion resistance[27] compared with uncoated substrates.

A track record of success

TiN has been used across multiple applications for more than two decades, including:

- Hip and knee arthroplasty[7, 17, 19]
- Dental implants[28]
- Surgical instruments[7, 24]

Results	Source
Total ankle TiN coated cementless. 49 implanted, average 5 year follow up, 0% revision attributed to loosening.[29]	Ankle International
THA TiN coated cementless. 130 implanted, average 6.4 year follow up. Cementless fixation survivorship of the acetabular and femoral components was 98.5%.[30]	The Journal of Arthroplasty
Total Knee TiN coated cementless 305 implanted, retrospective study at 10 years, 0.7% revision attributed to loosening and subsidence.[31]	Acta Orthopedics
Total Knee TiN coated cementless. 140 implanted, average 4.1 year follow up. None of the knees showed progressive or symptomatic radiolucent lines at any follow-up time point.[32]	Knee Surgery, Sports Traumatology, Arthroscopy
Hip resurfacing TiN coated cementless. 234 implanted, average 8 year follow up, 0.4% revision attributed to acetabular loosening.[33]	HIP International
Double-blind, randomized, controlled clinical trial assessed at 6 weeks, 6 months, 1, 5 and 10 years. 101 Patients received either a CoCr cementless or TiN coated cementless femur. Conclusion: "TiN-coated TKP does not influence the postoperative outcome of uncemented mobile-bearing TKA regarding postoperative pain, revision rate, range of motion, swelling and temperature of the knee." [34]	Knee Surgery, Sports Traumatology, Arthroscopy, The Journal of Arthroplasty



Engineered to endure

Triathlon Gold combines a titanium nitride (TiN) coating with a titanium (Ti-6Al-4V) substrate designed to deliver a durable,[9] biocompatible construct[35] with no deliberate addition of common metal sensitizers such as Ni, Co or Cr. The materials used to manufacture Triathlon Gold provide an option for patients with metal sensitivity and/or cement allergy concerns, without compromising implant performance[36, 37] or long-term durability.[9]

Scratch resistance

Triathlon Gold's TiN-coated surface offers scratch resistance superior to competitive surfaces,[10] helping protect against scratches from surgical instruments and third-body debris and to help preserve surface integrity during implantation and beyond.[37]

Wear performance

Triathlon Gold demonstrates wear rates equivalent to the established Triathlon CoCr femoral component, supporting excellent wear performance.[36]

Durability

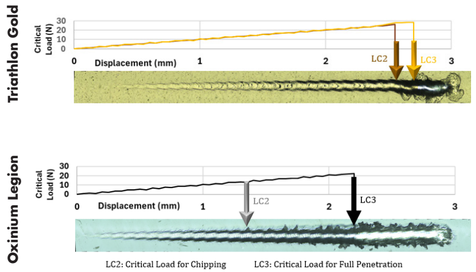
The titanium (Ti-6Al-4V) substrate combined with TiN coating makes Triathlon Gold a durable alternative to CoCr femoral component.[9]

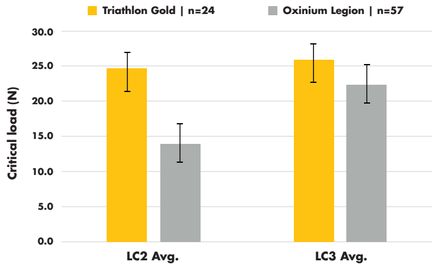
Triathlon Gold

Scratch **resistance**[10]

In a non-clinical two-sample t-test, Triathlon Gold (TiN-coated Ti-6Al-4V) demonstrated significantly greater scratch resistance than OXINIUM® Legion (oxidized Zr-2.5Nb) when tested per ASTM C1624.

TiN ceramic coating provides high scratch resistance and may help protect Ti-6Al-4V surfaces from damage that could otherwise compromise implant longevity.





Wear **performance**

The Triathlon Gold femoral component was designed with performance in mind. Stryker-performed testing has demonstrated the excellent wear performance and abrasion resistance of Triathlon Gold.

Rigorous wear testing following industry standards showed Triathlon Gold achieves wear rates equivalent to the clinically-trusted Triathlon design **(Figure 1)**.[36, 38] Importantly, polyethylene debris size and morphology were also shown to be comparable, suggesting no increased risk of osteolysis compared to Triathlon **(Figure 2)**.[36, 39]

To further assess Triathlon Gold for abrasion resistance, the same femoral components from the previously-referenced tests were exposed to TiN coated Ti-6Al-4V particulate for 3.0 million cycles, which is equivalent to 3 years of walking.[37, 40] Triathlon Gold had a small increase in surface roughness (Sa) as compared to data from literature of retrieved CoCr femoral components **(Figure 3)**.[41] Furthermore, the TiN coating showed no signs of cracking, delamination, gross spallation or substrate exposure as supported by the SEM data.[37] The results confirm that Triathlon Gold is engineered with tribology performance in mind.

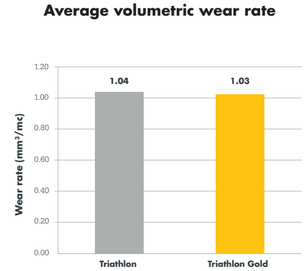


Figure 1.
Average volumetric wear rate for Triathlon Gold and Triathlon at the completion of wear testing

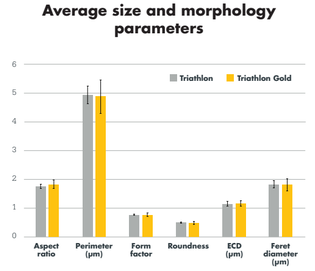


Figure 2.
Average polyethylene debris size and morphology parameters for Triathlon Gold and Triathlon at the completion of wear testing

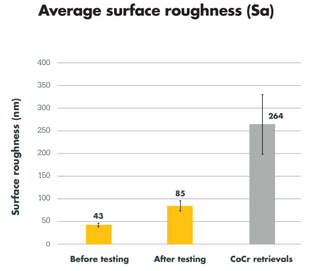


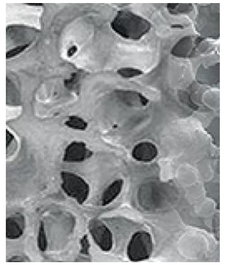
Figure 3.
Average surface roughness for Triathlon Gold before and after abrasive wear testing compared to CoCr retrievals

Trusted
Tritanium **technology**

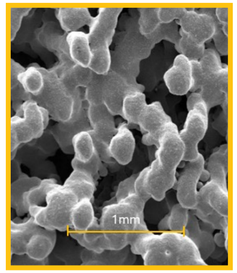
Triathlon Gold is produced using Stryker's additive manufacturing technology. Highly precise geometries are sintered together using a focused electron beam to grow the unique Tritanium implant structure, layer by layer.

Tritanium fixation technology features a controlled network of pores, designed to mimic the complex characteristics of cancellous bone, and to promote biological fixation.[42, 43] The surface roughness of Tritanium is precisely designed for uncompromising initial fixation performance.[44]

Cancellous bone



Tritanium



Average pore size[43]
465 microns

Average porosity[42]
55%

Surface* porosity[42]
81%

*Surface defined as depth of up to 200 microns

Images for illustration purposes only and may not represent all types of Tritanum implants.

Stryker implant	Survivorship	Source
Triathlon Tritanium Patella	98.1% all-cause survivorship in 35,087 Triathlon Tritanium Metal-Backed Patellae at mean 7 year-follow up.[12]	Journal of Orthopaedics
Triathlon Tritanium Baseplate	99.1% all-cause survivorship in 113 Tritanium Baseplate implantations.[3]	Journal of Arthroplasty
Triathlon Tritanium Cones	90.2% all-cause survivorship in 62 revision cases using Tritanium metaphyseal cones.[45]	Journal of Arthroplasty

Clinically-demonstrated fixation

Tritanium has an excellent proven track record of success across multiple Stryker implants.

Commercial launches with Tritanium

2014
Triathlon Tritanium Baseplate

2014
Triathlon Tritanium Patella

2015
Triathlon Tritanium Cones

2018
Trident II Tritanium Acetabular Shell

Dual-indicated fixation.

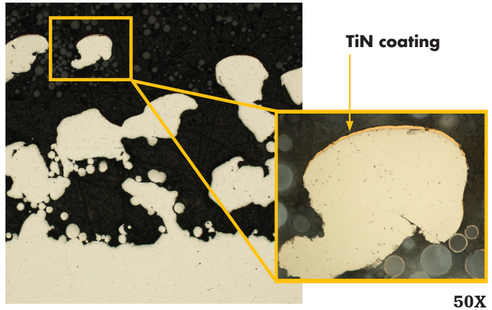
Cementless fixation

Triathlon Gold leverages additive manufactured Tritanium and its proven track record of success. TiN-coated, porous structures have demonstrated excellent clinical[29-34, 46] and animal study results.[47]

The animal study demonstrated that TiN-coated porous Ti-6Al-4V implants integrate with bone just as effectively as uncoated implants, with comparable tissue response and no increase in inflammatory or immune effects.[47]

Cement compatibility

Cement bond strength of Triathlon Gold's Tritanium surface has been shown to perform greater than legacy CoCr surfaces.[48, 49]



Triathlon Gold is dual-indicated for cemented or cementless use.

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Triathlon® Gold

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* For Mako Total Knee application, “cut less” refers to less soft tissue damage and greater bone preservation compared to manual surgery.

A surgeon must always rely on his or her own professional clinical judgment when deciding whether to use a particular product when treating a particular patient. Stryker does not dispense medical advice and recommends that surgeons be trained in the use of any particular product before using it in surgery.

The information presented is intended to demonstrate the breadth of Stryker’s product offerings. A surgeon must always refer to the package insert, product label and/or instructions for use before using any of Stryker’s products. Products may not be available in all markets because product availability is subject to the regulatory and/or medical practices in individual markets. Please contact your sales representative if you have questions about the availability of products in your area.

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