

Gas Nitriding recipe designed for the deepest case depths.



#### Capable of case depths up to 0.033"

(0.85mm). Case depths can be tailored for cost or performance. Note that processing time, and therefore cost increase exponentially with case depth. While there is no theoretical cap on achievable case depth, economic constraints can make certain case depths undesirable.

## POST-REACTION OXIDATION (PRO<sup>TM</sup>)

For a sleek black finish, we recommend our PRO<sup>TM</sup> surface finish. Following nitriding a secondary process is used to produce a professional black surface finish. Those familiar with liquid nitriding will recognize this as an Fe<sub>3</sub>O<sub>4</sub> oxide coating, but unlike liquid nitriding, this oxide layer doesn't change the surface finish of the part (no polishing required).

# MATERIAL CATALOGUE

Nitriding results are strongly influenced by the composition of the component. The presence of nitride-forming elements such as Al, Ti, V, and Cr will strongly influence the achievable hardness and the rate at which the case depth increases.

Typical case Deptilis			
Material	>50 HRC	>45HRC	
4330V	0.006-0.016"	0.012-0.025"	
	(0.15-0.4 mm)	(0.3-0.6 mm)	
4130	0.006-0.008"	0.009-0.01"	
	(0.15-0.2 mm)	(0.2-0.25 mm)	
4140	0.004-0.009"	0.009-0.012"	
	(0.1-0.2 mm)	(0.2-0.3 mm)	
4145	0.005-0.011"	0.008-0.012"	
	(0.1-0.25 mm)	(0.2-0.3 mm)	

#### **Typical Case Depths**

Most alloys including cast irons and low carbon steels will respond to nitriding. Consult with our engineering team for a complete list of materials.

# WHITE LAYER CONTROL



AIMax<sup>TM</sup> has been designed to keep the thickness of the compound layer to a minimum to avoid an overly brittle surface which could initiate surface cracking. Nitride networks are suppressed through careful recipe design in order to avoid creating crack propagation highways. Maintaining a thin white layer helps protect from chipping at sharp corners where nitriding occurs from 2 or more directions.

780-988-7789

# NAISS<sup>™</sup> Nitriding for Sour Service



# PROCESS

Thin-case gas nitriding recipe designed to replace liquid nitriding for applications where only minimal surface hardening is permissible.

CASE DEPTHS



Case depths controlled to ensure they are less than **0.006**" to conform to even the most stringent specifications. Process parameters are computer-controlled to ensure base material hardness is kept below **22HRC**.

	Radial Growth	of Part	
Material	Liquid	NAISS	
	(x10 <sup>-3</sup> in.)	(x10 <sup>-3</sup> in.)	
4330	0.37	0.17	
4145	0.35	0.07	

Relatively low process temperatures ensure minimal distortion due to nitriding. Let us handle your tightest tolerances.

## WHITE LAYER CONTROL

3µm ↓



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## TYPICAL MATERIALS

- 41XX
- 43XX
- QT-100

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Canadian Patent Application No. 3.044.930

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#### OVERVIEW

Apollo-SHIELD<sup>TM</sup> is a collaborative effort between Alberta Industrial Heat Treatment and Apollo-Clad Laser Cladding. This new patent-pending technology has been developed to combine the best aspects of Carburizing, Nitriding, Laser Heat Treatment, and Induction Heat Treatment.

#### PROCESS FEATURES

- Surface hardness greater than or equal to that of carburizing (>68HRC in some cases)
- Deep case depths of Induction Heat Treatment
- Low processing temperatures to limit distortion and maintain mechanical properties
- Ability to target specific features like Laser Heat Treatment to maximize value
- Hardness is consistently high throughout the case

#### MATERIALS

Hardening depends on specific grade. Alloy steels provide best results.

- o 4130, 4140, 4145
- o 4330V, 4340
- Constantly evolving catalogue

#### SELECTIVE HARDENING

Pretreatment hardens all exposed surfaces that aren't masked. Premium hardening unlocks maximum hardness.



Premium Hardened Region

#### **CASE DEPTHS** Premium Hardening Region:

Depth: 0.010"-0.060" (0.25mm-1.5mm)

Hardness: >65HRC (850-1000Hv) Typical

#### **Overall:**

Depth:0.020"-0.100" (0.5mm-2mm)

Hardness: 55-60 HRC (600-700 Hv)





**US Patent Application No. 16/507.285** 

**Canadian Patent Application No. 3.044.930** 



The hardening profile of Apollo-SHIELD<sup>TM</sup> is unique in that it features three distinct regions which combine to create the ideal case hardening treatment:

- Surface hardening on par with the hardest steels makes up the first 0.005-0.025", which provides resistance to galling and abrasion while lowering the coefficient of friction.
- Plateau of fully hardened base material (~55-60HRC for alloy steels) whose depth can be adjusted to control the overall case depth. This improves the resistance to contact fatigue when compared to diffusion hardening methods like nitriding.
- Abrupt return to base material hardness with minimal intercritical microstructures forming.

## APPLICATIONS

Apollo-SHIELD<sup>TM</sup> can improve almost any components which are currently being Nitrided, Carburized, Laser Heat Treated or Induction Heat Treated.

Common applications include: bearing surfaces, mill gearing, rollers, crankshafts, camshafts, etc.

# IMPROVEMENT OVER CONVENTIONAL HEAT TREATMENT



to wear mechanisms 400 galling, and contact 300 fatigue

> throughout the life of the component

Nitriding:

Apollo Shield Nitriding Hardness (HV 0, As guenched 4330V 200 0 0.000 0.025 0.075 0.050 0.100 Quick drop in Depth From Surface (inches) hardness results in accelerated wear

# DISRUPTIVE TECHNOLOGY

One of the biggest challenges for design engineers is balancing bulk properties (strength, toughness) with surface properties (hardness, wear-resistance). Carburizing is popular for its relatively deep case depths, but it requires the use of specific grades (8620 and 9310), which are expensive and have relatively low strength. Alloy steel like 4330V can have double the yield strength of 8620 and is substantially cheaper but obtaining the hardness and case depth of carburization has been impossible until now.

Unlike carburizing, Apollo-SHIELD<sup>TM</sup> doesn't require a quench, which minimizes distortion and maintains the final temper properties of the core material (suitable for finished parts).

Pin-On-Disk testing confirms a significant improvement (2.6x better than untreated steel) in wear performance compared to conventional surface hardening methods (nitriding).



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# Patent-Pending Apollo-SHIELD™ <

HEAT TREATING INC.

US Patent Application No. 16/507,285

Canadian Patent Application No. 3,044,930



Fig.1 Wear loss relative to untreated AISI 4145 material. Apollo-SHIELD<sup>™</sup> hardened 4145 demonstrates a 260% improvement over untreated material, and a 185% improvement over nitrided 4145 as measured with Pin-On-Disk testing.



Fig.2 Wear scars of nitrided 4145 (left) and Apollo-SHIELD<sup>TM</sup> 4145 (right) following Pin-On-Disk testing.



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# **Gas Nitriding for Stainless Steels**



# PROCESS

Specialized Gas Nitriding procedure for stainless steels. Improvement over liquid nitriding for high Cr materials.



#### Capable of case depths up to 0.008" (0.2

**mm).** Stainless alloys are rich in nitride forming elements (most notably Cr), which results in high hardness, but limited case depth.



Gas nitriding is not only capable replicating the results of conventional salt-bath (liquid) methods, but can also be tailored to achieve deeper case depths.

# TYPICAL MATERIALS

- o 13-8
- o 15-5
- o 17-4

## SURFACE ACTIVATION

The greatest difficulty with nitriding stainless steels is removing the passivation layer which will otherwise inhibit the process. One of several physical or chemical methods can be used to "activate" the surface for nitriding. Some alloys are more difficult to activate than others, and may require more aggressive techniques. In most cases surface finish is unaffected.

# ADVANCED RECIPE DESIGN

Stainless steels are much more complex alloys to nitride, and require expert process control to achieve quality results. Understanding process kinetics, and the development of metastable phases is important to ensure desirable results. If not properly controlled, stainless steels can be prone to forming brittle white layers, or inconsistent/non-existent cases. Certain grades can experience changes in their mechanical properties or can develop defects if treated at the wrong operating temperature including a reduction in corrosion resistance. Consult our experts to find a procedure that suits your application.

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# Recipe Development and Quality Control

# HEAT TREATING INC.

# EXPERT R&D TEAM

Alberta Industrial is invested in provided timely, professional technical support to our customers. This is why AIHT is supported by a team of 5 engineers – 3 with Ph.D.'s in Metallurgy and 1 with a Masters in Materials Engineering.

Our experts have 50 years of combined experience in the field of engineering including an intimate understanding of materials, heat treatments, and surface engineering technologies. Such a level of technical expertise is rarely found even in much larger companies. With this powerhouse of experience and fundamental understanding, AIHT is confident that we can find a solution to even your most challenging projects.

#### RECIPE DESIGN AND OPTIMIZATION



Combining fundamental process understanding with the reliability of our automated furnaces gives unparalleled predictability and consistency. Process parameters are chosen based on fundamental materials science. This approach leads to shorter development cycles and improved control over our processes. If we don't have a suitable recipe in our catalogue, we will do the development work for you!!!

## METALLURGICAL LAB



Our metallurgical lab is **fully equipped**, allowing for internal development without relying on any third-party labs. Our facilities include:

- o 2 Full time Technicians
- Wire EDM and machining capabilities
- Microhardness Testing and polishing capabilities
- ISO 9001:2015 3<sup>rd</sup> party calibration
- Optical Microscope
- o Stereomicroscope
- Tensile/Compression Testing
- Charpy Impact Testing
- One-of-a kind large scale Fatigue Tester
- o Residual Stress Testing
- ASTM G65 Testing

#### TESTING POLICY

Our state-of-the-art equipment removes the need for batch testing. We pass these cost savings on to our customers. Nondestructive testing methods are used where appropriate for quality screening. Test coupons are run with every load, and are subject to surveillance auditing. **Batch testing and comprehensive furnace charts available upon request.** 



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# **Recipe Development and Quality Control**



#### EQUIPMENT



You are only as good as your equipment! Our state-of-the-art nitriding furnaces utilize temperature and atmosphere sensors to control processing conditions in real time. Closed-loop feedback ensures operating conditions are representative of the recipes prescribed by our expert metallurgists.

#### RELIABILITY



Touchscreen controls and graphic-userinterface simplify operation and remove the need for manual intervention by an operator. Recipes are pre-programmed by the engineering team, and the process is fully automated.

Every recipe has been developed from fundamental material science, and has been tested to ensure compliance. State-of-the-art sensors and controls are used to ensure repeatability beyond what is possible with manual operation. Sensors are tested regularly to ensure they are functioning properly. Case depth analysis is done through random sampling. Batch testing is available upon request.

#### QUALITY CONTROL

Our process features industry leading safety measures to protect both our staff and

customer parts. In the unlikely event of a process interruption, our furnaces will undergo a nitrogen purge to ensure parts return to room temperature in an inert atmosphere. The



9001:2015

process can then be resumed without any adverse effects. Our comprehensive Quality Management System ensures full traceability.



What sets our process apart is our focus on fundamental material science. With a team of 3 Ph.D. Materials Engineers, we are truly unique in the industry. We use this strength to design optimized procedures, and the highest quality results. With over 30 active recipes, we have something to fit every need.

# CUSTOMER SERVICE

At AIHT it isn't just good enough to sell a process. We want to sell you the best process for your application. **Our experts are here to serve you!** 



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