

# PASSIVATION OF STAINLESS STEEL SPRINGS:

## Process, Benefits, and Specifications

A TECHNICAL GUIDE BY PLYMOUTH SPRING COMPANY, INC



# Introduction

Stainless steel springs are fundamental components across critical industries such as medical, automotive, aerospace, and electronics, offering exceptional mechanical strength, durability, and corrosion resistance. However, fabrication processes like machining, coiling, or forming can introduce surface contaminants—especially free iron—that compromise corrosion protection.

Passivation is a post-fabrication chemical process that removes exogenous iron and restores the protective passive layer, significantly enhancing corrosion resistance without affecting mechanical properties or dimensions.

As components become more miniaturized, complex, and mission-critical, ensuring surface integrity is no longer optional. For example:

- In aerospace systems, even minor corrosion can lead to part failure in high-vibration or high-altitude conditions.
- In medical implants, contamination risks are directly linked to patient safety and regulatory compliance.
- In automotive safety systems, corrosion resistance contributes directly to long-term reliability under temperature and humidity cycling.

This white paper provides a detailed overview of the passivation process, its mechanical and chemical benefits, the most commonly passivated stainless steel grades, and the industry standards that define compliance and performance, including ASTM A967, ASTM F86, and AMS 2700.

By understanding the role of passivation in stainless steel spring performance, engineers can make more informed material and finishing decisions—ensuring components that are not only strong, but also stable, safe, and specification-ready.

# +25%

## Stainless Steel

stainless steel is estimated to account for over 25% of all spring materials used globally in regulated industries due to its superior performance in aggressive and high-precision environments.

From life-saving medical devices to high-performance aerospace assemblies, stainless steel springs are relied upon for their combination of mechanical strength, fatigue resistance, and corrosion protection.

However, the corrosion resistance of stainless steel is not solely inherent—it is surface-dependent. During coiling, forming, or machining operations, free iron and particulates from tooling or handling can embed into the surface, disrupting the protective chromium oxide layer and increasing susceptibility to rust, pitting, and contamination.

# What is Passivation

## What is Passivation?

Passivation is a chemical surface treatment used to remove free iron and other contaminants from stainless steel surfaces. Unlike plating or coating, passivation does not alter the part's dimensions or surface appearance. Instead, it enhances the naturally occurring chromium oxide layer, restoring corrosion resistance after fabrication.

### Typical Passivation Process:

1. **Cleaning:** Removal of lubricants, oils, and shop debris using alkaline or solvent cleaners.
2. **Acid Bath Immersion:** Exposure to nitric or citric acid solutions, which dissolve free iron and exogenous particles.
3. **Rinse & Dry:** Thorough rinse with deionized water followed by controlled drying to prevent spotting or recontamination.

## Engineering Benefits of Passivating Stainless Steel Springs

- **Enhanced Corrosion Resistance:** Mitigates rusting and pitting, particularly in marine, medical, or chemical environments.
- **Improved Cleanliness:** Essential in biomedical, aerospace, and semiconductor sectors where contamination must be minimized.
- **Biocompatibility:** Critical for implantable medical devices and instruments requiring residue-free, non-reactive surfaces.
- **Surface Uniformity:** Delivers a clean, consistent finish suitable for inspection and assembly.
- **Regulatory Compliance:** Ensures conformance to military, FDA, and aerospace specifications.

## Common Stainless Steel Grades Used in Springs

Grade	Type	Key Attributes
302	Austenitic	High corrosion resistance, excellent formability and spring-back characteristics
304	Austenitic	Most common grade; versatile, cost-effective, good overall corrosion resistance
316	Austenitic	Superior chloride resistance; ideal for marine and medical applications
17-7 PH	Precipitation Hardening	High strength, excellent fatigue life, moderate corrosion protection
430	Ferritic	Low cost; limited spring applications due to reduced corrosion resistance

## Key Passivation Specifications

ASTM A967 – Standard for Chemical Passivation of Stainless Steel

The industry-wide benchmark, ASTM A967, outlines acceptable procedures for nitric and citric acid treatments. It includes:

- Approved chemistries and concentrations
- Process flexibility (multiple options for bath formulation and temperature)
- Required test methods, including:
  - Water immersion
  - Salt spray (ASTM B117)
  - Copper sulfate testing
- Acceptance criteria and documentation guidelines

ASTM F86 – For Surgical Instruments and Implants

Specifically designed for medical devices, ASTM F86 mandates:

- Cleaning and surface preparation for biocompatibility
- Passivation methods that avoid altering implant material properties
- Assurance of non-pyrogenic, residue-free surfaces suitable for in-body use

AMS 2700 – Aerospace & Defense Standard

AMS 2700 is a more stringent specification, particularly relevant for aerospace, military, and high-performance industrial sectors. It requires:

- Specific identification of process types (e.g., Type 2 = Citric Acid, Type 6 = Nitric Acid)
- Precise control of bath temperature, immersion time, and concentration
- Robust traceability, certification, and repeatable process control
- Comprehensive testing and documentation to meet aerospace-grade reliability

## Why It Matters: Performance and Compliance

Passivation is not optional in demanding applications—it's a critical step to protect your investment in stainless steel springs. Whether the end-use involves:

- Sterile surgical equipment
- Aircraft flight controls
- Automotive brake systems
- Robotics in corrosive environments

...proper passivation per recognized specifications ensures maximum lifespan, safe operation, and regulatory adherence.

## Plymouth Spring: Your Partner in Precision Protection

At Plymouth Spring Company, we understand the performance and quality expectations of engineers and OEMs. We offer:

- Coordinated passivation services
- Guidance in selecting the optimal specification for your application and material
- Support for traceability and documentation is required for regulated industries
- Precision spring manufacturing expertise backed by decades of experience

## Contact Us

Let us help you design and finish stainless steel springs that exceed expectations and perform under pressure.

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