NANHAIYA ADVANCED ALLOY REINFORCEMENT TECHNOLOGIES

FOR SCREWS & BARRELS

Internal Technical Reference

Three Technologies. One Goal: Longer Service Life. Better Performance.

CONTACT INFORMATION

Add: Block C, No.2 West Section, Xingzhou Avenue, Dinghai District, Zhoushan City, Zhejiang Province

Tel: +86-13866163221 | Fax: 0580-8835106

E-mail: info@nhyscrews.com | Web: www.nhyscrews.com

PART 1 | OVERVIEW

During plastic extrusion, injection molding, compounding, pelletizing and recycling, screws and barrels operate under continuous high-temperature, high-pressure and friction conditions.

Depending on the processed material, screws and barrels may be exposed to:

- Abrasive wear
- Sliding wear
- Filler-induced wear
- Corrosive wear
- High-temperature wear
- Local impact & stress-related wear

Severe wear conditions are commonly found when processing:

High-$CaCO_3$-filled plastics · Glass-fiber-reinforced plastics · WPC compounds · Recycled plastics · Engineering plastics · Mineral-filled compounds · Corrosive materials (PVC)

Therefore, a standard nitrided surface is not always sufficient for every processing condition.

NANHAIYA organizes its major alloy reinforcement technologies into three main categories:

1. PTA Hardfacing

Plasma Transferred Arc Hardfacing — screw working surfaces, flights and critical wear areas.

2. HVOF Coating

High-Velocity Oxy-Fuel Coating — screw surfaces and barrel bores.

3. Centrifugally Cast Bimetallic Barrel

Continuous high-performance alloy working layer inside the barrel bore.

PART 2 | MAIN FAILURE MECHANISMS

2.1 Abrasive Wear

Abrasive wear is one of the most common causes of screw and barrel damage. Hard particles such as calcium carbonate, glass fiber, wood flour, mineral fillers, contaminants and hard particles in recycled plastics can continuously abrade the screw and barrel surfaces.

Long-term operation may result in:

- Screw flight wear
- Changes in screw channel geometry
- Enlarged barrel bore
- Increased clearance
- Reduced plasticizing efficiency
- Unstable extrusion pressure

2.2 Corrosive Wear

Certain polymers and processing conditions may create corrosive environments. PVC processing may involve corrosive decomposition products under unsuitable thermal conditions.

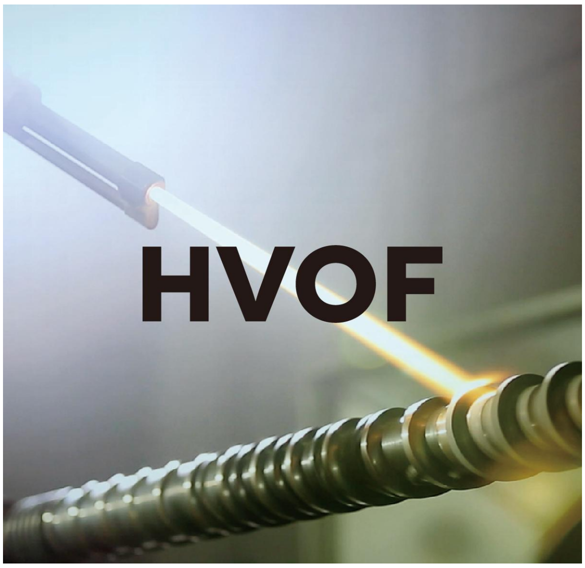
Hardness alone is not sufficient for corrosion-sensitive applications. Material selection should also consider: alloy chemistry, chromium content, nickel-based corrosion resistance, coating porosity, surface integrity and bonding characteristics.

2.3 Combined Wear Conditions

High-filled materials may involve several degradation mechanisms simultaneously: **Abrasion + Temperature + Corrosion**. Possible solutions include wear-resistant screw materials, high-performance bimetallic barrels, PTA hardfacing and HVOF hard coatings.

PART 3 | OVERVIEW OF THE THREE TECHNOLOGIES

TECHNOLOGY	MAIN COMPONENT	PROCESS TYPE	MAIN FEATURE
PTA	Screw	Hardfacing	Metallurgical bonding and localized reinforcement
HVOF	Screw / Barrel Bore	Thermal spray	High-velocity deposition and dense wear-resistant coatings
Centrifugal Casting	Barrel Bore	Bimetallic manufacturing	Continuous alloy lining for full-bore protection



PART 4 | PTA HARD FACING

4.1 What Is PTA?

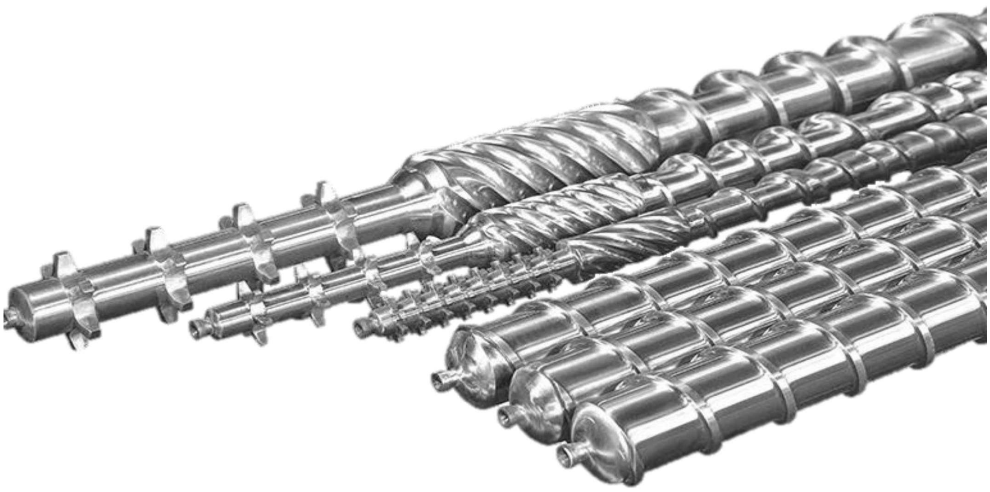
PTA stands for **Plasma Transferred Arc**. It is a high-energy surface engineering process used to melt and deposit alloy powder onto a metal substrate. With proper process control, the deposited layer can form **metallurgical bonding** with the substrate.

4.2 Typical Screw Applications

PTA is particularly suitable for: screw flights, flight tips, critical wear areas, mixing sections, high-wear conveying sections, local repair areas and dimensional restoration.

Screw Flight Hardfacing

The screw flight is often one of the most critical wear zones. PTA can therefore be used to reinforce these critical areas.



4.3 Main Advantages

- ✓ **Metallurgical Bonding** — deposited hardfacing layer forms a metallurgical bond with the base material.
- ✓ **Localized Reinforcement** — critical wear areas can be selectively reinforced.
- ✓ **Dimensional Restoration** — worn screw surfaces can be rebuilt and subsequently machined.
- ✓ **Flexible Material Selection** — different hardfacing materials can be selected according to the application.

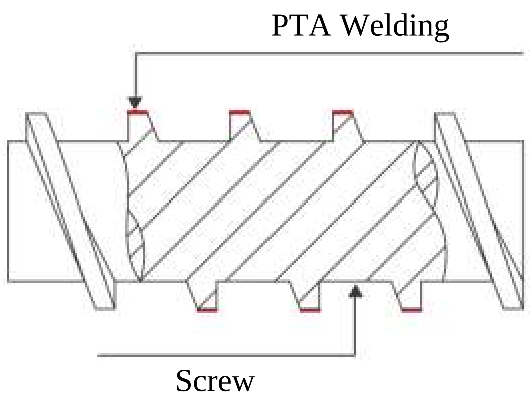
4.4 Typical PTA Material Systems

Fe-Based Alloys — good wear resistance, cost-effective, suitable for general to moderate wear.

Co-Based Alloys — good high-temperature performance, good wear resistance, suitable for demanding conditions.

Ni-Based Alloys — good corrosion resistance, good wear resistance, suitable for aggressive environments.

Carbide-Reinforced Systems — tungsten carbide, chromium carbide, mainly for severe abrasive wear.



PART 5 | HVOF COATING

5.1 What Is HVOF?

HVOF stands for **High-Velocity Oxy-Fuel**. It is a thermal spray technology that uses oxygen and fuel to generate a high-velocity combustion gas stream, accelerating coating particles toward the workpiece surface.

Key characteristics include:

- High particle velocity
- High coating density
- Relatively low porosity
- Strong wear-resistance potential
- Compatibility with various carbide and alloy powder systems

5.2 Applications for Screws and Barrels

HVOF can be applied to screw working surfaces, screw flights, high-wear areas, as well as barrel bores and internal working surfaces.

5.3 PTA vs. HVOF

Important Technical Note: HVOF should not generally be described as "metallurgical bonding." PTA and HVOF are different technologies and should be clearly distinguished in technical documentation.

5.3 PTA vs. HVOF (continued)

ITEM	PTA	HVOF
Process Type	Hardfacing / Cladding	Thermal Spray
Heat Source	Plasma Transferred Arc	Oxy-Fuel Combustion
Deposition Principle	Molten alloy overlay	High-velocity particle deposition
Bonding	Metallurgical bonding	Thermal spray coating bonding
Main Advantage	Local reinforcement and repair	Large-area surface protection
Typical Application	Screw flights	Screw surfaces and barrel bores

5.4 Available HVOF Material Systems

Fe-Based — general wear, cost-sensitive

Ni-Based — corrosion resistance, combined wear+corrosion

Co-Based — high-temperature, demanding wear

Tungsten Carbide (WC-Co, WC-CoCr) — high hardness, severe abrasion

Chromium Carbide (Cr_3C_2-NiCr) — high-temperature wear, oxidation resistance

PART 6 | CENTRIFUGALLY CAST BIMETALLIC BARREL

6.1 What Is a Bimetallic Barrel?

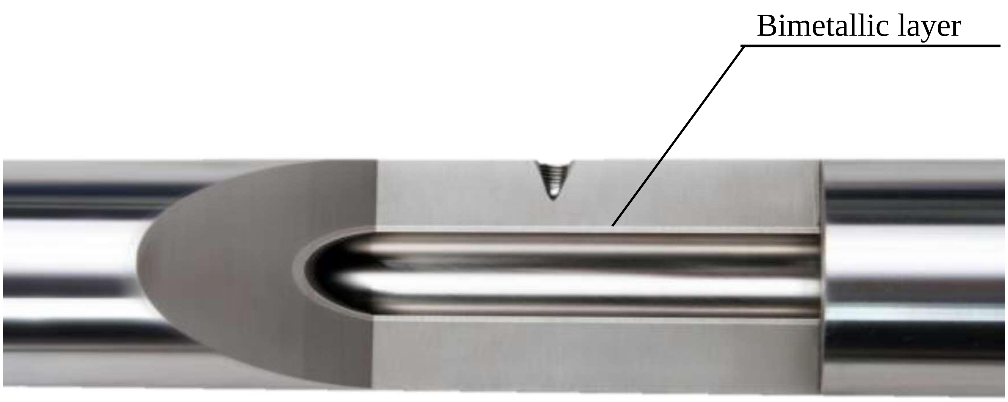
A bimetallic barrel combines a **high-strength steel body** with a **wear-resistant and corrosion-resistant alloy lining** inside the bore. The steel body provides mechanical strength and dimensional stability; the alloy lining provides wear resistance, corrosion resistance and extended service life.

6.2 Basic Principle

During centrifugal casting, the cylindrical component rotates under controlled conditions. Molten alloy is introduced and distributed along the barrel bore by centrifugal force. After cooling, solidification, precision boring and finishing, the required barrel bore is produced.

6.3 Why Centrifugal Casting Is Suitable for Barrels

A barrel is a long cylindrical component, making centrifugal casting particularly suitable for creating a continuous alloy lining inside the bore. Compared with localized reinforcement, a centrifugally cast bimetallic barrel can provide continuous protection along the complete working bore.

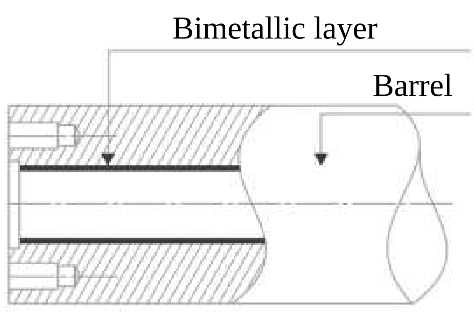


PART 7 | BIMETALLIC BARREL ALLOY REFERENCE SYSTEM

The following table can be used as an internal alloy-selection framework.

ALLOY GRADE	MAIN ALLOY SYSTEM	REFERENCE HARDNESS	ABRASION RESISTANCE	CORROSION RESISTANCE	RECOMMENDED APPLICATIONS
Type A	Fe-Cr-Ni	HRC 58–62*	★	★	Recycling, engineering plastics, low-filled reinforced materials
Type B	Ni-W-Cr	HRC 60–64*	★★	★★	Moderate corrosion and medium-to-high filler content
Type C	Co-W-Cr-V	HRC 62–65*	★★★	★★	High abrasion and moderate corrosion applications

*These figures are based on competitor catalogue information supplied for internal reference. Final NANHAIYA product specifications must be confirmed by actual production capability and inspection data.



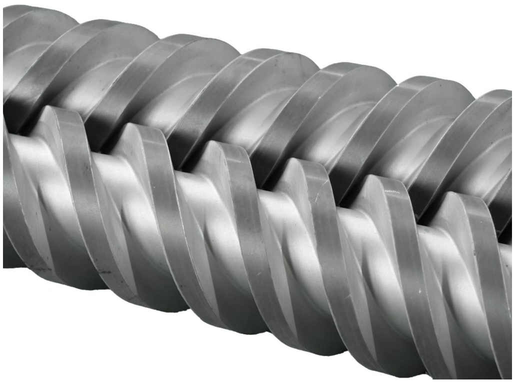
PART 8 | SCREW MATERIAL SYSTEMS

Depending on the application, possible material categories include: nitriding steels, stainless steels, tool steels, and powder metallurgy steels. Selection should consider polymer type, filler content, corrosion risk, processing temperature, required service life and cost target.

PART 9 | COMPARISON OF COMMON SURFACE TECHNOLOGIES

TECHNOLOGY	PROCESS METHOD	WORKING LAYER	TYPICAL APPLICATION
Nitriding	Gas / Ion Nitriding	Diffusion-hardened layer	General plastic processing
Hard Chrome	Electroplating	Thin chromium layer	Specific low-friction and corrosion applications
HVOF	High-Velocity Oxy-Fuel	High-performance thermal spray coating	High-abrasion plastics
PTA	Plasma Transferred Arc	Metallurgically bonded hardfacing layer	Screw flights and critical wear areas

Technical Note: Nitriding is *not* PVD. This is an important distinction when preparing professional technical documentation.



PART 10 | PTA HARDFACED BIMETALLIC SCREW

Product Concept: PTA hardfacing is used to reinforce critical screw working areas with wear-resistant and corrosion-resistant alloy materials. Typical applications include screw flights, high-wear areas, local repair and dimensional restoration.

Main Advantages: Excellent wear-resistance potential, flexible alloy selection, corrosion-resistant material options, metallurgical bonding, targeted reinforcement of critical wear areas.

PART 11 | HVOF ALLOY-COATED SCREW

Product Concept: HVOF technology can be used to apply high-performance wear-resistant coatings to screw working surfaces.

Main Advantages: High-velocity particle deposition, high coating density, relatively low porosity, strong wear-resistance potential, flexible material selection (WC, Cr_3C_2, Ni-based, Co-based, Fe-based).

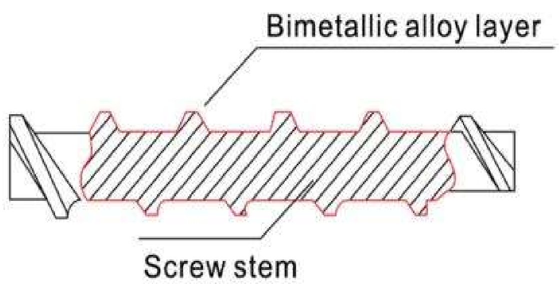
Recommended Applications: High-$CaCO_3$ compounds, glass-fiber-reinforced plastics, WPC materials, highly abrasive recycled plastics, high-mineral-filled compounds.

PART 12 | HVOF BARREL BORE REINFORCEMENT

HVOF can also be used as a barrel bore surface reinforcement technology. The general process may include surface preparation, HVOF coating, precision boring or finishing, and final dimensional inspection. This technology may be considered for high-wear barrel applications, selected repair requirements and special processing conditions.

PART 13 | COMPREHENSIVE COMPARISON

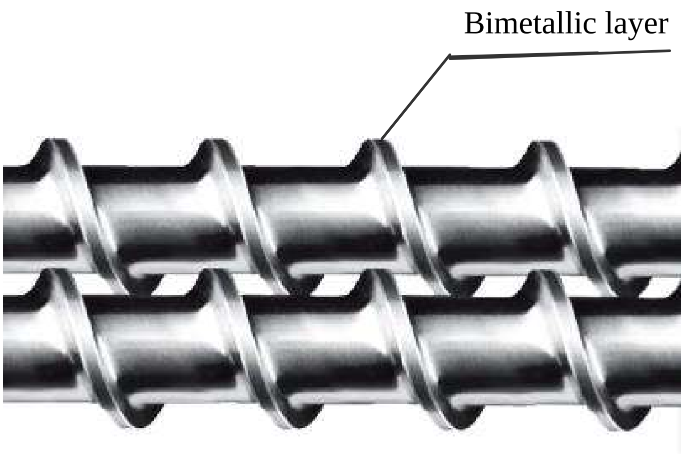
ITEM	PTA	HVOF	CENTRIFUGAL CASTING
Main Component	Screw	Screw / Barrel Bore	Barrel Bore
Process Type	Hardfacing	Thermal Spray	Bimetallic Manufacturing
Feedstock	Alloy Powder	Alloy Powder	Molten Alloy
Main Bonding Feature	Metallurgical Bonding	Thermal Spray Bonding	Composite Lining Structure
Main Purpose	Local reinforcement and repair	Large-area surface reinforcement	Full-bore protection
Final Machining	Required	Usually required	Required



PTA spray welding screw sectional drawing

PART 14 | MATERIAL SELECTION LOGIC

PROCESSED MATERIAL	MAIN RISK	SCREW RECOMMENDATION	BARREL RECOMMENDATION
PP / PE	General wear	Nitrided or suitable material	Nitrided barrel
Recycled Plastics	Abrasive wear	PTA / HVOF	Bimetallic barrel
High $CaCO_3$	Severe abrasion	PTA / HVOF	High-wear bimetallic barrel
Glass-Fiber Plastics	Severe abrasion	HVOF / PTA	High-grade bimetallic barrel
WPC	High abrasive wear	PTA / HVOF	Bimetallic barrel
PVC	Corrosion + wear	Corrosion-resistant alloy system	Corrosion-resistant bimetallic barrel
Highly Filled Engineering Plastics	Severe wear	Advanced alloy reinforcement	High-grade bimetallic barrel



PART 15 | INTERNAL TECHNICAL SELECTION PRINCIPLES

The correct solution should **not** be selected based on: *"Higher hardness is always better."*

A professional selection process should evaluate:

- Polymer type
- Filler type
- Filler percentage
- Particle size
- Corrosion conditions
- Processing temperature
- Screw speed
- Operating pressure
- Required service life
- Customer budget

PART 16 | TECHNICAL COMMUNICATION GUIDELINES

The following claims should **not** be used without verified test data:

- ❌ "All products provide 12 times longer service life."
- ❌ "All HVOF coatings have HRC 64."
- ❌ "All alloy layers are 3 mm thick."
- ❌ "All bimetallic products have the same service life."

> ✅ **Professional Statement:** By selecting an appropriate alloy system and reinforcement technology according to the actual polymer formulation, filler content, wear mechanism and processing conditions, the wear resistance, corrosion resistance and service life of screws and barrels can be significantly improved.

ZHOUSHAN NANHAIYA

PLASTIC MACHINERY CO., LTD

Add: Block C, No.2 West Section, Xingzhou Avenue, Dinghai District, Zhoushan City, Zhejiang Province

Tel: 0580-8835106 | **Fax:** 0580-8835106

M.T/WhatsApp: +86-13866163221

E-mail: info@nhyscrews.com

Web: www.nhyscrews.com