

Huasheng Nanotechnology DLC Coating

I. Core Process: Multi-Technology Integrated DLC Coating System

With over a decade of expertise in the DLC coating field, **Huasheng Nanotechnology** has established an integrated production system that combines **PECVD** as the core process with **PVD hybrid enhancement technologies**. By leveraging proprietary structural designs and equipment innovations, the company has achieved simultaneous breakthroughs in both coating performance and production efficiency.

1. Plasma-Enhanced Chemical Vapor Deposition (PECVD)

Core Technology

A closed magnetic field environment is created using a composite magnetic field design, with high substrate bias applied to efficiently ionize carbon-containing gases such as acetylene. This results in a **plasma density over 40% higher** than traditional processes.

Key advantages include:

Deposition rate exceeding 1 $\mu\text{m}/\text{h}$, 2–3 times faster than conventional processes;

Deposition temperature below 150°C, preventing thermal deformation of precision parts;

Smooth, particle-free coating surfaces, eliminating the need for post-polishing treatment.

2. PVD Hybrid Process Enhancement

For demanding applications, Huasheng integrates **magnetron sputtering (MS)**, **high-power impulse magnetron sputtering (HiPIMS)**, and **arc ion plating (AIP)** to develop hybrid processes such as “MS + PECVD” and “MS + Arc Evaporation.” The **HiPIMS** technique achieves a high ionization rate and controllable frequency reversal pulses. With a unified cathode design, **film density increases by 30%**, and adhesion strength remains stable at **HF1 grade**.

The **arc ion plating** process precisely controls target current (20–400A) and chamber

pressure (0.1–5.0Pa), effectively solving the industry challenge of high internal stress and delamination in thick coatings.

3. Precision-Controlled Production Workflow

A standardized process covers every step from pretreatment to post-treatment: ultrasonic and plasma cleaning combined with argon ion etching ensures optimal surface cleanliness and adhesion.

A **Cr or Ti transition layer** is magnetron-sputtered with thickness precisely controlled between 50–200 nm. The proprietary **planetary rotation substrate holder** ensures coating uniformity deviation $\leq 5\%$.

II. Customized Product Portfolio: DLC Coatings for Diverse Applications

Leveraging core technologies and over 100 intellectual property rights, Huasheng Nanotechnology has developed **four major categories of DLC coatings**, precisely designed for different substrates and working conditions—especially in precision transmission systems.

1. General Hydrogenated DLC Coating (a-C:H)

Designed for precision thin-walled components such as shafts and harmonic reducer flexsplines, this coating balances performance by adjusting the **sp³ bond ratio**, achieving **hardness of 1500–2500HV** and a **dry friction coefficient of 0.05–0.1**. With **2–4 μm thickness** and low-temperature deposition, part tolerance is maintained within **0.005 mm**, and fatigue life is **over twice that of conventional quenching treatments**.

2. Ultra-Hard Hydrogen-Free DLC Coating (ta-C)

Using graphite as the carbon source, the coating achieves an **sp³ bond ratio above 80%**, resulting in **hardness of 4000–6000HV** and a **wear rate as low as 10^{-8} mm³/N·m**.

Ideal for cycloidal gears in RV reducers and other heavily loaded components, it maintains **dimensional stability for over 8,000 hours** under high-frequency contact, meeting the stringent wear resistance demands of semiconductor equipment.

3. Doped Functional DLC Coatings

Metal-doped (Ti-DLC / Cr-DLC): For hard-to-bond substrates such as powder metallurgy gear shells, metal doping enhances adhesion, achieving **neutral salt spray test durability beyond 1500 hours**.

Non-metal-doped (F-DLC / Si-DLC): The self-developed **hydrophobic F-DLC** coating exhibits a **water contact angle over 110°**, providing excellent anti-sticking performance; **Si-DLC** improves chemical corrosion resistance by **50%**, suitable for medical sterilization and semiconductor cleanroom environments.

4. Multilayer Composite DLC Coating

Adopting a **“metal transition layer + tough interlayer + ultra-hard top layer”** gradient design combined with **pulsed laser arc deposition**, this structure resolves issues of high stress and poor thermal stability.

When applied to harmonic drive generator bearings, it achieves **high hardness (outer ta-C layer up to 5000HV)**, **toughness (intermediate a-C:H layer fracture toughness 2.5 MPa·m^{1/2})**, and **low friction ($\mu = 0.06$)**, ideal for cyclic loading and instantaneous high-stress applications.

III. Equipment Strength: Independently Developed

High-End Coating Systems

As one of the few domestic enterprises capable of both **equipment R&D and coating services**, Huasheng Nanotechnology operates **over 70 advanced vacuum coating systems**. Core equipment performance indicators meet international standards, providing strong hardware support for DLC coating quality.

1. Core Coating Equipment

Pulse Arc Coating System (TC800): Equipped with a 400A pulse arc power supply, magnetron power, and pulse bias supply, enabling simultaneous arc and sputtering operations. Deposition efficiency is **20% higher** than comparable imported systems.

Multifunctional Composite Coating System (DLC1500): Integrates PECVD and magnetron sputtering with a **non-equilibrium closed-field magnetic simulation design**, ensuring uniform plasma coverage for complex-shaped parts.

2. Intelligent Auxiliary Systems

The **planetary rotation substrate holder** uses elastic clips and gear-driven mechanisms for multidirectional motion, achieving **coating uniformity deviation $\leq 3\%$** .

The self-developed **intelligent control software** automates the coating process, reducing operational complexity and maintenance costs by **over 30%**.

IV. Benchmark Applications: From Precision Components to Advanced Equipment

Huasheng Nanotechnology's DLC coating technology has been widely adopted across high-end manufacturing industries, empowering domestic parts manufacturers to overcome foreign technical barriers.

1. Precision Transmission

For leading domestic harmonic reducer manufacturers, Huasheng customized a **hydrogenated DLC + Ti transition layer** solution, extending product fatigue life from **8,000 to 22,000 hours**.

The coating successfully replaced Japanese alternatives and has entered the **new energy vehicle and robotics supply chains**.

2. Cutting Tools and Machinery

The **AlCrN/DLC hybrid-coated tools** feature a nano-multilayer design, improving high-temperature stability by **40%** and wear resistance by **2–3 times** over conventional coatings.

For pipeline interiors, the company applies **anti-corrosion DLC coatings** via pulsed power deposition, achieving **international-level wear and corrosion resistance**.

3. Medical and Electronics

For **surgical robot bearings**, Huasheng provides **biocompatible DLC coatings** resistant to sterilization environments. Specialized **electronic component coatings** combine insulation with wear protection, safeguarding precision parts in high-end electronics.

V. Technological Advantages: Global Competitiveness

Rooted in Local Innovation

With its “**Technology Innovation + Full-Chain Service + Cost Efficiency**” strategy, Huasheng Nanotechnology has built a leading competitive edge in China’s DLC coating sector, driving domestic innovation in advanced surface treatment technologies.

1. R&D and Certification Strength

The company operates **doctoral workstations and engineering technology centers**, with **over 100 intellectual property rights** covering processes, equipment design, and material formulations.

Innovations such as **hydrophobic DLC** and **internal pipeline coating** have filled domestic technology gaps, achieving parity with leading institutions like **Germany’s Fraunhofer Institute** and top Japanese manufacturers.

2. Full-Process Service Capability

Huasheng offers **end-to-end services**, from pre-sale condition analysis and customized coating design to process optimization and quality tracking. Its **30,000 m² manufacturing center** and multi-site facilities enable rapid response to customized needs, shortening equipment delivery cycles by **50%** compared to foreign suppliers.

3. Cost and Performance Efficiency

By developing proprietary coating equipment and leveraging large-scale production, Huasheng reduces per-unit coating costs by **over 50%** versus imported brands. Through process optimization, coating performance matches international standards, helping clients **cut lifecycle costs by 50%** while achieving both **high performance and cost efficiency**.