PVD, PACVD and CVA Coatings for the Aerospace Industry

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Ionbond Group Overview

A global leader in the CHF 1 bn coating services market.

- 2013 sales CHF 130 million
  985 employees
- Headquarters in Zürich, Switzerland
- 38 coating centers in 17 countries
  Europe, North America, Asia
- Broadest technological offering on the market
  - PVD
  - CVD
  - PACVD
  - CVA
Aerospace Applications

- Thin Film Coatings in Aerospace
  - Modern solution for increase of reliability and lifetime of mechanical components;
  - Environmentally friendly alternative to other coating technologies (e.g. electroplating);
  - Ability to boost performance while reducing weight, use of less expensive materials;
  - Indirect impact: Improving efficiency of manufacturing technology – cutting, forming, casting;
Thin film coatings are applied for protection against:

- Erosion;
- HT Oxidation and hot corrosion;
- Fretting;
- Galling/seizure;
- Surface fatigue;
- (Sand) sticking;
- Thermal impact (TBC);
- General corrosion.
Jet Engine: Erosion Protection

- Erosion of compressor blades:
  - Leads to:
    - power loss,
    - higher fuel consumption and emission of pollutants;
  - Manifests as:
    - leading and trailing edges chord loss;
    - profile change;
    - tip loss;
  - Caused by ingestion of sand, fly ash, salt, ice

- PVD coatings are applied on blades for protection against erosion in LPC and HPC;
Jet Engine: Fretting Wear Protection

- Fretting motion occurs between dovetail joint (root) of a blade and disk;

- Fretting: adhesive transfer of material between contacting surfaces: leads to pits, abrasive wear, crack formation;

- Remedies:
  - High hardness – PVD coatings;
  - Low friction – PVD coatings;
  - Material selection – PVD coatings;
  - Compressive stress – PVD coatings.
Micro Spark Coating (MSC) is a variant of electro spark deposition;

- Protects against wear and fretting at normal and elevated temperatures;

- Wide range of deposited materials, including application-specific compositions;

- Thickness of more than 50µm; repair applications are possible;

- Applications: shrouds, blade tips, cladding repair, labyrinth seals.

Low pressure turbine shroud: welding (above), MSC coating (below)

Source: IHI Corp.
Applications on Aerospace Fasteners

- **Function:**
  - Protection against galling and seizure;
  - Corrosion protection;

- **Working temperatures from -60 of up to 800 C;**

- **Traditional coating:** Ag electroplating; Cd plating (not permitted for the engine use);

- **Potential replacement:** TiN, CrN, CrON; DLC (for temperatures < 350 C);
CVD Aluminizing (CVA)

- Diffusion bond coating for turbine components; Ni<sub>x</sub>Al<sub>y</sub> intermetallic based;
- Provides protection against HT oxidation and hot corrosion; forms alumina (TGO) for reliable bonding of TBC layer;
- Halide CVD process for aluminizing;
- Alternative to powder-based techniques (pack, out-of-pack, slurry);

Ionbond Bernex CVD Aluminizing Reactor
Applications for Airframe Components

Protection against fretting is one of the most common coating applications;

Use of fretting-prone materials (Ti, Al, SS) in combination with vibrations accentuates fretting issues;

Spherical bearings, mounts, knuckle joints are among typical components benefiting from thin film coatings;

Typical coatings are nitrides and carbon-based films;
Thin Film Coatings use in aerospace industry increases; however they still remain a relatively exotic solution;

High cost of testing and ‘risks of change’ deter quicker penetration of thin films;

In certain aerospace applications, thin films are ‘designed-in’ solutions for wear and corrosion protection;

Further promotion of thin film benefits will help with their broader acceptance in the industry;