Ionbond, The Surface Engineers™

The Ionbond group is a leading high-quality provider of advanced coatings and coating equipment, with a focus on thin film coating technologies.

Headquartered in Zurich, Switzerland, the company employs more than 900 employees across 17 countries in Europe, North America and Asia. Ionbond traces its beginnings to the Swiss truck manufacturer Berna. Established as part of Berna's Bernex Surface Metallurgy division in 1972 to provide CVD equipment and technology, the company strongly expanded its technology portfolio over the years and became independent in 2004 under the name Ionbond. Today Ionbond offers the broadest range of thin film technologies, including PVD, CVD, PACVD, and CVA and is very well positioned as the second largest company in the worldwide wear protection coating market.

As of the end of 2012 Ionbond is part of IHI's machinery division as is its sister company Hauzer Techno Coatings of Venlo, Netherlands which has been owned by IHI since 2008. Hauzer specializes in PVD and high volume PACVD equipment engineering, manufacturing and marketing.

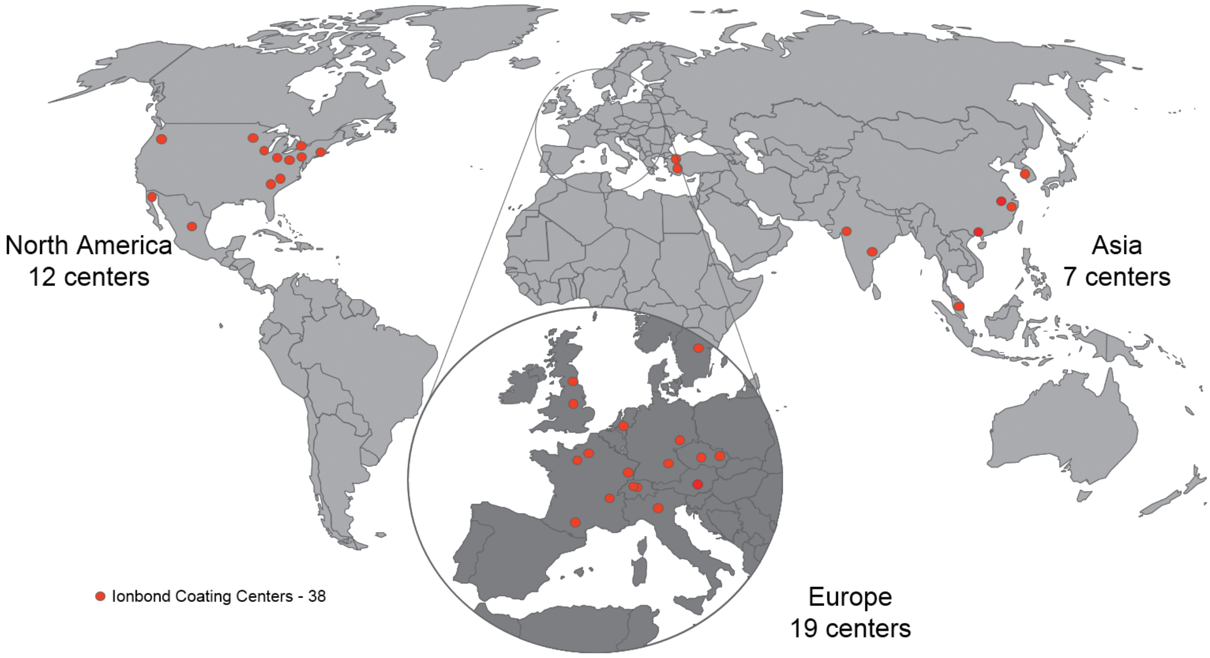
Ionbond operates in two main business units: coating services and equipment.

(1) The coating services unit provides high-quality PVD, CVD and PACVD coating services for a wide range of tooling applications and components.

(2) The equipment unit offers CVD and CVA thin film deposition equipment.

Coating services are currently offered through a worldwide network of 38 coating centers. Additional coating centers are planned for the next years including one in Japan (Nagoya

Ionbond Venlo 10 000 m^2 automotive competence center



Ionbond Coating Center Network

area) in the 2015/16 time frame. The centers hold various quality accreditations such as ISO 9001, 9002, 14001, 13485 and 10993-1 (medical), TS 16949 (automotive), AS 9100 and NADCAP (aerospace).

Ionbond CVD and CVA equipment is engineered and manufactured in Olten. Maintenance and spare parts are provided through the worldwide after sales service organization.

Surface Technologies

Material treatment technologies can be split into heat treatment and surface technologies. Heat treatment includes techniques such as annealing, case hardening, precipitation strengthening, tempering and quenching, which are mainly used to harden or soften a material. Surface technology, Ionbond's core activity, is considered the high tech variant and includes the application of coatings to the surface of objects to improve their properties.

Coatings improve the surface characteristics and performance by means of enhanced wear resistance and reduced friction which lead to increased lifetime and reduced lubrication needs. The improvements for coated tools and components can be as significant as lifetime extensions of 5-20 times versus uncoated. Thus the coatings can lever significant value to the end user.

Key differentiating factors of the existing surface technologies are coating temperature, coating thickness and hardness. Based on the coating technologies used, the coatings market can be divided into three main segments: thin film coating, thick-film coating and traditional galvanization (electroplating). Ionbond is active in thin film coating PVD, CVD, PACVD and CVA technology.

Physical vapor deposition (PVD)

PVD is characterized by the creation of a metal vapor which can be reacted with different gases to form a thin film coating. The most common PVD methods used today are arc deposition and sputtering. Both processes are carried out under high vacuum conditions within a coating chamber. The typical process temperature ranges between 250°C and 450°C, although in some cases PVD coatings can be deposited at temperatures below 70°C or up to 600°C. The coatings deposited usually are TiN, AlTiN, TiAlN, CrN, CrCN, TiCN and ZrN, as well as more complex alternatives

London 2012 Olympic torch coated with Decobond™ PVD

PVD coated cutting tools

such as TiSiN and AlCrN. Coating thicknesses typically range from 2 to 5 µm, but in certain cases coatings can be as thin as 0.5 µm or as thick as 15 µm or more. The coatings can be deposited as mono-layers, multi-layers, graded layers and the coating structures can be modified to obtain different properties in terms of hardness, elasticity, adhesion etc. The typical cycle time ranges from 3-6 hours, depending on load density, coating type and thickness.

The PVD process is capable of depositing coatings on a very large range of tools and components. Applications include cutting tools, warm and cold forming tools, components, medical applications and decorative items. Substrate materials range from steels and carbides to pre-plated plastics. End-users can be found in a range of sectors including the automotive industry, general engineering, aviation, consumer goods and medical sector.

The main advantages of PVD are:

- Wide choice in terms of substrate materials as well as coating materials and combinations
- Short cycle times / high productivity
- Parts maintain their geometry and tolerances thanks to low to moderate coating temperatures
- High ionization rate
- Compressive stress within the film preferred for high speed drilling and milling operations
- Low coefficient of friction
- Environmentally friendly process

Chemical vapor deposition (CVD)

CVD is a heat-activated process which relies on the reaction of gaseous chemical compounds. Ionbond’s technology origins from the Bernex™ CVD process developed in the 1970s and has been continuously improved since. The typical process temperatures range between 900°C and 1 050°C for the high temperature and 720°C and 900°C for the mid temperature processes. Typical coatings are deposited in multi-layers made of TiC, TiCN, TiN and alpha and kappa aluminium oxide. Coating thickness typically ranges from 5 to 12 µm, but in some cases coatings can be as thick as 20 µm and more. Cycle times can last from 8 to 24 hours, depending on the thickness of the coating applied. The most common items coated are tungsten carbide inserts for machining, punches and metal forming tools and extrusion dies. Other applications exist for components that are subject to abrasive or corrosive environments. The range of substrate materials includes carbides, tool steels, high nickel content alloys like Inconel and Hastelloy, ceramics and graphites. Due to the high temperature of the process, most steels require heat treatment after coating.

The main advantages of CVD are:

- Extreme toughness of coatings
- High loading capacity
- Items to be coated do not require rotation within the retort

Ionbond Bernex™ CVD system

CVD coated inserts for machining

- Excellent coating uniformity
- Possible to coat complex geometries, including certain inner contours
- Economical production of thicker coatings
- Tensile stress within the film preferred for inserts used for turning operations

Plasma assisted chemical vapor deposition (PACVD)

PACVD is used to deposit extremely smooth, well adhered Diamond-Like Carbon (DLC) coatings in a high vacuum environment at temperatures below 200°C. The process is characterized by a high throwing power and the fact that no solid target or cathode is used as is the case for the PVD process. In addition, in some cases parts do not need to be rotated in the chamber. PACVD is a clean, reliable, high technology coating process. PACVD coatings are amorphous in structure and contain around 70% sp3 bondings, which gives the coatings its high hardness. The low friction DLC coatings deposited are designed for specific application environments. The process can deposit coatings on a broad range of substrates, including both conductive and insulating materials. Common applications include engine and machine components, pump parts, medical devices and decorative items. End-users range from the automotive and aerospace industries, to the energy, medical and consumer goods sectors.

DLC coated automotive components

PACVD combines both PVD and CVD benefits with the main advantages:
- Wide choice in terms of substrate materials
- Short cycle times / high productivity
- The low to moderate coating temperatures means parts maintain their geometry and tolerances
- Excellent coating uniformity on a range of geometries (not a line-of-sight process)
- The process is environmentally friendly
- Possible to coat certain inner diameters

The current trend, especially for automotive components, is coatings that are composed of a combination of PVD and PACVD, with PVD usually serving as a base layer to support a PACVD finishing layer. Therefore most modern coating equipment has the ability to do both processes.

Chemical Vapor Aluminizing (CVA)

CVA is based on the CVD process and is used for the production of diffusion aluminide coatings for high temperature applications. In the 900-1 050°C process, aluminum diffuses into the substrate to produce intermetallic compounds — aluminides. The CVA process is designed to create homogeneous aluminide diffusion layers with controlled thickness, aluminum content and structure on special high temperature nickel alloys. Both low and high-activity aluminides can be deposited on internal and external areas of components. Besides simple aluminides, the Bernex™ CVA process is capable of delivering precursors for the deposition of complex coatings with the addition of Cr, Si, Co, Hf, Y and other elements.

The aluminides offer remarkable resistance to high temperature oxidation and corrosion. Therefore, they are suitable for corrosion protection of blades in the hot section of turbines. The Bernex™ CVA is an advanced technology that offers an environmentally friendly, better-performing alternative to traditional pack, out of pack and slurry technologies. In addition, the Bernex™ CVA guarantees:
- Environmentally friendly processes, not generating waste powders
- Precise control over the deposition process
- Possibility to coat internal cooling channels
- Uniform coating thickness over large areas
- Possibility to produce multi-material coatings
- Low surface defects density

Inquiries:
IHI Ionbond
Phone: +41-44-298-50-82
Website: www.ionbond.com/