Dear Customer,

I am pleased to present our latest issue of the Equipment News, in which I have the pleasure of introducing our Electrical & Software Engineering department. In addition to that, we are pleased to present the latest developments in terms of coatings and equipment.

Our coating systems comprise a plethora of components and modules, including the control software and hardware, which is under constant development. Every day, our specialists are hard at work, programming new tools to make our equipment more reliable, more flexible and, above all, safer. In this issue, we present the latest developments that came out of our Electrical & Software Engineering department. One of the huge advantages of our software updates is that they can be easily installed via remote connection or with a small USB stick. Our engineers are more than happy to answer any questions you may have concerning system compatibility.

In addition, I have the pleasure of showing you our latest advances in the CVA coatings development. Chemical Vapor Aluminizing (CVA) is used for the production of Aluminum diffusion coatings (Aluminates). These coatings show an extraordinary resistance against high temperature oxidization and corrosion. This is why they are predestined for the protection of turbine blades and other components for the hot section of engines. Furthermore, the CVA technology has additional advantages, such as the fact that it is environmentally friendly (no waste products in powder form), it provides precise control over the coating process, it yields a uniform coating thickness over large substrate areas, and many more. Our Product Management Team presents the field in more detail on the following pages.

In the New Products section, we introduce our new Low Pressure System for CVD coating equipment. This extension of the process pressure range in CVD coating technology opens the door for new developments in the tool coating industry.

Extensive maintenance contracts are an ever recurring issue. They guarantee uninterrupted and professional maintenance of your equipment and make sure that you can minimize your system downtime. Our Customer Service team is happy to negotiate a maintenance contract that corresponds exactly to your needs.

With kind regards,

Christian Behlinger
Head Customer Service
CVD LOW PRESSURE SYSTEM

The Bernex™ BPXpro Low Pressure System is designed to achieve process pressures below 50 mbar. This allows for completely new coating development applications.

The Low Pressure System is installed between the newly conceptualized pressure regulation valve and the Neutralization System. Its versatile design principle allows for seamless integration into any customer’s floor footprint.

The module consists of one or more Liquid Ring Vacuum Pumps, one or two sequential dry vacuum pumps and dedicated valves. All pumps and valves (including the Neutralization System) are installed on a maintenance friendly frame.

The pumping capacity of the Low Pressure System can be custom tailored by means of adjusting the piping size and the entire pumping system configuration. Thus, the pressure achieved is a function of the total gas flow and the capacity of the installed vacuum pumps.

<table>
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</tr>
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<td>35</td>
<td>200</td>
</tr>
<tr>
<td>40</td>
<td>225</td>
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</tbody>
</table>

Legend
A: 2 stage pumping system
B: 2 stage pumping system (higher capacity)
C: 3 stage pumping system

CVD TiAlN produced with the Low Pressure System.
Only properly and timely maintained coating equipment can adhere to the stringent safety requirements of the industry.

In accordance with your requirements and priorities, Ionbond develops a custom tailored maintenance contract in order to keep your equipment in the nominal condition.

Such a maintenance contract contains the following scope of service:

- The specification of the maintenance interval
- A preliminary inspection in order to define the required spare parts
- Various tests prior to actual maintenance
  - leakage tests
  - condition of components
- The actual maintenance
  - Liquid and Gas Cabinets
  - general system components
- Recommissioning of the system
  - Leakage test
  - Winding and insulation of heating tapes
  - Refilling of liquid tanks
  - Heating tests for all reactors
- Testing phase
  - including a full process cycle
NEW CONTROL SOFTWARE FUNCTIONS

MFC-RANGE EDITOR

The newly developend MFC-Range editor is a small auxiliary program, which enables the quick editing and adjustment of the MFC ranges. The program proves especially useful when existing MFC should be replaced in order to achieve higher or lower flow rates.

Stop configuring your MFCs through complicated procedures and upgrade to the new MFC-Range Editor.

Among the features of the MFC-Range editor is the capability of manually adjusting the minimum and maximum set point values, and many more. Custom features are available on request.

To sum up, the MFC-Range editor has the advantage that you can be more independent in your Research & Development endeavours and that you are able to make seemingly simple adjustments to MFC settings by yourself.
Ionbond introduces the new Recipe Editor with loop functionality.

The loop functionality of the Recipe Editor is a newly developed advancement of the recipe database, introducing the possibility of processing selected recipe steps in so-called loops. This means that individual recipe steps can be repeated a specified amount of time, which can save you valuable time. In addition, changes to existing recipes become easier and more flexible to manage. Integration of old recipes is seamless, which means that updating the Recipe Editor on existing equipment is possible without the adjustment of the recipe data. Of course, recipes without loops are still possible.

As an additional feature of the new Recipe Editor, individual recipe steps can be grouped into blocks. Blocks allow for a combination of recipe steps to be looped as a whole. This makes the creation of more complex recipes easier than ever before.

<table>
<thead>
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<th>Block</th>
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<th>Time/Temp</th>
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</tbody>
</table>

Nano-multilayer coating made with looped recipe steps
COMPUTER INTERLOCK SYSTEM

The BPXpro Computer Interlock System for maximum control with minimum effort.

Many of our customers chose to install their equipment with their Main and Aux control computers located in different locations. In such a case, it is of vital importance that both computers are under control at all times, since process related control inputs can originate from both locations at the same time, which can lead to complications.

Ionbond has developed a simple, but elegant tool that guarantees that control input can only occur from one computer at a time.

With the Computer Interlock System, user input permissions are distributed and controlled by means of three lights, displayed in the upper right corner of the Main Screen. The green light on the right indicates full coating system control for the corresponding computer. Permissions can be locked for the other computer by activating the red light.

Once locked, full user input permissions can be requested by activating the green light. This is indicated on the other computer by means of the orange light, which begins to flash. Such permission requests can be granted or denied, depending on the current state of operations.

With the Computer Interlock System by Ionbond, it is always guaranteed that only authorized personnel execute critical commands, which is also an important factor in relation to safety in the workplace environment.
A SNEAK PEEK INTO...

THE ELECTRICAL & SOFTWARE ENGINEERING DEPARTMENT

It is an honor for me to introduce another core department of the Ionbond Equipment division. Picture a skeleton, an empty frame. Now add some muscle and, on top of that, some veins and arteries carrying the blood to the organs.

What we now need is a brain, a central intelligence to control these muscles and transport of fluids. In our coating systems, this task is managed by the control hardware and software, which is what we from the Electrical & Software Engineering Department are concerned about.

Modern automated control systems must be versatile. They must be flexible, available at all times, simple in design, never fail, and, above all, be absolutely safe. Selected components should be state-of-the-art, ecologically and economically viable and be ready to work all over the world. In addition, all systems documentation must be easy to read and be available in multiple languages on a variety of media. All this is taken care of by the Electrical & Software Engineering Department. With the aid of professional CAD and CAE systems, our experienced engineers are responsible for the design of custom CVD, PVD, PACVD, CVA, and other control systems according to the latest risk assessment and harmonized standards and directives. Proper documentation and processes allow for highly customized and flexible control systems, which can be maintained over exceptionally long periods of time.

For many, interaction with machinery without the use of software is inconceivable. An intelligent software solution must be aware of the requirements of the users and (re)act in a proactive manner. In other words, it must be able to communicate with the user without interrupting the ongoing workflow. Our unique concept control system is able to do exactly that and as simple to use as it is easy to adjust to specific customer requirements. In close collaboration with customers and the process engineering team, our experienced software engineers are able to design a specific solution, from the coating process definition up to the visual appearance and system documentation. We support various software solutions on a broad spectrum of operating system generations, which is another factor as far as longevity is concerned. Based on all these factors, we are able to provide fast and competent customer support.

Hüseyin Cankaya
Head Electrical & Software Engineering

**Electrical & Software Engineering Team**

Hüseyin Cankaya
Head Electrical & Software Engineering

Rolf Schranz
Software Engineer

Mathias Drews
Software Engineer

Martin Weber
Hardware Engineer
CVA COATINGS DEVELOPMENT

Chemical Vapor Aluminizing (CVA) is a process, whereby Al-based coatings are produced by means of reactive Al chlorides. The Al chlorides are reduced from hydrogen and subsequently form Al deposits on metal surfaces.

Modern protective coatings on components of the hot section of turbine blades typically comprise two layers – an underlying bond layer and a top thermal barrier coating (TBC). Most frequently used bond layers consist of inward grown nickel aluminide (β-NiAl) coatings produced by the diffusion of aluminum in the nickel-containing base material. Al chlorides are carried to the substrate surface by means of a dedicated gas distribution system. In case of nickel-containing super alloys, the end-product is an inter-metallic coating with a composition of AlNi_y (3 ≥ y ≥ 1/3). Modern CVA technology enables the production of alloyed coatings (e.g. Chromium, Silicon, etc.) by offering substantially improved process control and process repeatability.

Next to the development efforts that led to the formation of NiAl on various base alloys in CVA processes in order to produce a body of reference data, this article demonstrates how these coatings were modified by means of the addition of metal elements such as Si and Cr. Various concentrations of Si and Cr in the coatings were studied, with variations in process temperature and gas composition. One of the findings of these case studies is that the CVA coating structure primarily depends on the concentration of aluminum sub-chloride and the deposition temperature. Based on these two main factors, a variety of coatings diffusion structures can be obtained:

- LTHA (Low Temperature High Activity) – Inward Al diffusion with 3 zones structure (heat treatment required)
- HTLA (High Temperature Low Activity) – Outward Ni diffusion with 2 zones structure
- HTHA (High Temperature High Activity) – Inward Al diffusion with 2 or 3 zones structure

The following example (Fig. 1) illustrates the typical results of Al-diffusion and the formation of NiAl on IN-718.
of an NiAl layer. It shows a coating structure and elemental profile of an aluminide coating with a clearly defined Al-rich $\delta$-Ni$_2$Al$_3$ phase on IN-718. Based on the analysis, the coating has a coating structure typical for CVA HTHA. Three distinct layers can be identified, with an Al-rich $\delta$-Ni$_2$Al$_3$ phase located on the surface (Al content up to 60%). Since this phase is hard and brittle, additional heat treatment is usually applied in order to form the $\beta$-NiAl phase.

Fig. 2 shows a typical HTLA coating on an IN-600 substrate. Two coating zones are clearly identifiable with a prominent $\beta$-NiAl layer.

Fig. 3 and Fig. 4 illustrate examples of more advanced element profiles. On the basis of Al diffusion technology and the process flexibility of CVA, the addition of various metal elements was studied. Both figures show a 6 $\mu$m Si doped coating with 5% (Fig. 3) and 12% (Fig. 4) Si, deposited on IN-600 base material.

Besides Si-modified coatings, Cr-modified aluminide coatings promise substantial improvements and protection against hot corrosion. The HTHA chromium aluminide coating was produced in the temperature range 1000 – 1060 °C in two steps; chromizing followed by an aluminizing step. The 3-zone structure demonstrates inward aluminum diffusion during the coating process.
cycle by leaving the chromium content almost intact, and as an under-layer between the “hy-
po-stoichiometric” $\delta$-Ni$_2$Al$_3$ and the inter-diffu-
sion zone. In addition, the chromium content
near the surface is low (10-16% Cr, 23% Ni, 10% Fe and 55% Al), when compared with the content
in the LTHA chromium aluminide coating.

The capabilities of CVA technology as a multi-
step process with precise control of process pa-
rameters enables sequential processing, e.g.
aluminizing as a first step, followed by the next
layer, such as the addition of Cr. Naturally, this
sequence can be reversed, i.e. aluminizing be-
comes the last step of the coating process. This
flexibility is an inherent characteristic of the CVA
process and offers numerous advantages in
comparison to conventional cementation, where
combination of various deposition steps is im-
possible in a single batch and requires replace-
ment of the reactive powders.
From October 18 to 20 2016, we will be at Eurotool 2016 Trade Fair in Krakau, Poland, and we will present our newest developments and products.

We are looking forward to your visit.
Come visit us at JIMTOF 2016 Trade Fair in Tokyo, Japan, from November 17 to 22 2016, where we will present the latest developments in the Equipment market.

We are looking forward to your visit.
Ionbond is a global leader in surface enhancement technology and has been dedicated to serving high-demanding industries such as tool making, automotive, industrial, aerospace, racing, medical and many others with its coating equipment for the past 40 years. This has enabled a deep understanding of the materials requirements and future trends facing these industries.

Ionbond also has a global presence with coating centres in strategic locations ready to work in partnership with manufacturers and their suppliers to provide cost-effective solutions to the most pressing needs facing the industry.

With ISO 9001 and specific certifications for individual industries and numerous manufacturer approvals Ionbond is the partner for equipment as well as coating services.

See our Website for a full list of our coating centers.

www.ionbond.com