

**Development**

**Coatings**

**Equipment**

high quality thin films by



**PT&B SILCOR GmbH**



## PT&B SILCOR GmbH - About the company

In the year of 1998 three physicists founded PT&B SILCOR GmbH. The enterprise is spin-off from the Otto-von-Guericke University of Magdeburg. During their academic carriers at various German and US-universities, the founders had acquired profound knowledge of different vacuum plasma coating technologies and the characterization of thin films.

These are the established branches of the business of PT&B SILCOR:

**Development of novel technologies and coatings according to specific needs and on order of customers – R&D projects as service.**

**Job-coating services – coatings of the portfolio of SilCor®coatings**

**Engineering, design and manufacture of coating equipment**

Therefore, the business activity of PT&B SILCOR is a unique mix of a research institute, a job-coater and an equipment manufacturer.

A particularly high customer use develops upon vertical arrangement of the services: PT&B SILCOR GmbH carries out the entire work from the development of a coating to the supply and lasting support of the coating equipment.



## SilCor®DLC - Thin films for novel solutions

Thin films of diamond-like carbon (DLC) with a typical thickness of 2 micrometers are deposited in vacuum-vessels. Simply spoken, DLC consists of intermediate phases of nanometer-size clusters of diamond and graphite. A variety of new applications were realized:

- Mechanical engineering and automobile industry: Drive components, bearings, seal elements, steering gear racks, springs, pistons and others.
- Tools: Primary shaping tools, forming tools and cutting tools for non-ferrous metals (especially aluminum)
- Chemical industry: Valves, fittings, seals, reactor walls
- Medical and pharmaceutical technology: hydrophobic surfaces for reduced germ setting and advanced sterilization, bio- and hemo-compatibility
- Design: Valuable surfaces for decoration and consumer durable goods



### Specific Characteristics

- The coatings are completely smooth and dense, free of cracks and holes. There is no increase of the roughness due to the coating.
- Very high corrosion resistance against salts, acids and leaches
- Hardness up to 3500 HV (Vickers) or 35 GPa (Universal)
- Stable up to temperatures of 350°C under ambient air
- Coefficient of friction: 0.03 – 0.2 (unlubricated, depending on friction partner)

### Deposition

The deposition of SilCor®DLC is performed by means of a plasma-discharge in carbon-hydrogen gases – a technology referred to as “Plasma-CVD”. The process itself is a complete new technology developed by PT&B SILCOR GmbH. This process results in a variety of superior features of this special DLC coating:

- Very good adhesion to all metals as tungsten carbide, aluminum, stainless steel, copper, high speed steel – but also on glass, plastics, ceramics
- Minimum deposition temperature of 60°C (140°F)
- Inner coatings of tubes, boreholes and grooves



## SilCor®SiC – The hard anti-sticking coating

By adding silane gas to the plasma, the DLC is transformed into a hydrogenated amorphous silicon-carbon alloy  $a\text{-Si}_x\text{C}_{1-x}\text{:H}$  (abbreviated SiC) with a variable fraction  $x$  of silicon. The addition of silicon increases the temperature stability, the oxidation resistance and the electrical insulation. The surface energy of the coatings is significantly reduced resulting in non-sticking and non-wetting behavior. Due to a reduced built-in stress thick films up to 50 $\mu\text{m}$  can be deposited. There is the possibility for very efficient inner coating of tubular shapes.



## Applications of SilCor®SiC

The coatings show their unique good characteristics at all processes combined with unwanted adhesion or wetting of surfaces by liquid substances. Due to the improved coating thickness also surfaces of minor quality become electrical insulating and highly corrosion resistant.

- Plastics processing: Coated molds for injection and blow molding
- Medical technology: Permanent implants and prostheses or temporary interventional and diagnostic devices
- Chemical technology: Protection of metallic parts from aggressive media
- Food industry: Reduced sticking of dairy, pastry and meat products
- Micro engineering and sensor technology: Laser structuring, SiC in combination with metallic films for sensors or electrode systems

### Specific characteristics of SilCor®SiC

- Surface energy of minimum 25mN/m
- Very hydrophobic, anti-sticking and anti-wetting behavior
- High corrosion resistance against salts, acids and leaches
- Strongly insulating – typically  $10^{13} \Omega\text{cm}$  specific resistance
- Hardness up to 2300 HV (Vickers) or 23 GPa (Universal)
- Excellent surface quality on all components – no measurable increase of roughness due to coating

SilCor®DLC and SilCor®SiC coatings are available by the job-coating service of PT&B SILCOR or are implemented in deposition equipment which is for sale. The maximum dimensions for parts to be coated are 800mm (~ 32 inch) diameter, 1100mm (~ 44 inch) height and 500kg (~ 1100 lbs) mass.



## SilCor®CrN – The silver shining coating

The metallic silver appearing hard coatings of chromium and chromium nitride are at different points of view a useful alternative to DLC coatings:

- There is, for example in medical technology and pharmacy, the explicit need for a film appearing metallic silver
- The component coated has to withstand temperatures above 400°C (752°F)
- Operation of the coating in a strongly oxidizing environment
- The coating must show a high optical reflectance
- There is the need for a metallic conductive coating

SilCor®CrN coatings are deposited by sputtering – a special technology of physical vapor deposition – from solid chromium cathodes and nitrogen gas at temperatures below 200°C (392°F). The surface quality of parts coated remains unchanged after coating. Quite in contrast to Arc-PVD no “droplets” appear. Other features of the films are a Vickers-hardness of 2300 HV and a specific electrical resistivity of  $10^{-2} \Omega\text{cm}$ .

Under ambient air the temperatures resistance of the CrN coatings reaches 700°C (1292°F). Similar like chromium the coating forms a self-passivating oxide film resulting in a high corrosion resistance.

Chromium nitride coatings are widely used in pharmaceutical industry for the production of tablets by compacting tools. Especially wear resistant surfaces can be obtained by coatings made of SilCor®CrN plus SilCor®DLC. These double coatings are successfully used for compacting tools applied to abrasive coarse-grained powders. Other applications of CrN are medical technology using coated surgical instruments and plastics processing industry.

The job-coating with SilCor®CrN is possible for parts of maximum dimensions of 600mm (~ 24 inch) diameter, 900mm (~ 35 inch) height und 250kg (~ 550 lbs) mass. All deposition equipment by PT&B SILCOR is available with the know-how for the above coatings.



## Engineering and manufacture of coating equipment

PT&B SILCOR employs two different technologies of plasma vacuum coating: The sputtering (a physical vapor deposition technology) is in use to deposit metals, metal oxides or nitrides. The Plasma-CVD (chemical vapor deposition) is for coatings of carbon, silicon and their alloys as, silicon oxide for example. The unique feature of PT&B SILCOR is the capability of parallel handling both processes. Therefore, a broad variety of coatings exist which can be even combined. For the customers this means to obtain optimum coatings for their products within a short term.



The essential components for both deposition technologies, which are sputter-magnetrons and plasma-sources, respectively, are developed and manufactured by PT&B SILCOR GmbH. The complete know-how for the deposition process as the handling of vacuum pumps, the gas inlet system and the plasma generators are implemented into a SPS running under windows operating systems on PC. This way, buying deposition equipment from PT&B SILCOR GmbH enables our customers to integrate the coating process in their production lines.

The dimensions of the vacuum chambers for sputtering, Plasma-CVD or combined processes range from some ten centimeters up to two meters. For the specific customer's needs, design and dimensions of the vacuum chambers are optimized. The deposition equipment being in use for job-coating at PT&B SILCOR as the STARON 60-80 (combining sputtering and PCVD) or STARON 100-120 (PCVD) are available for demonstration to customers.





## Development of novel technologies and coatings

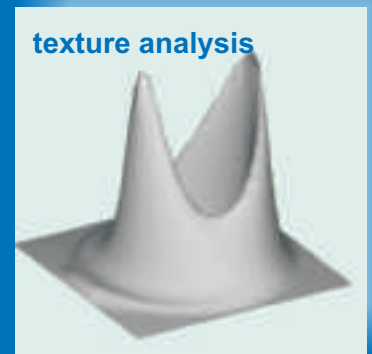
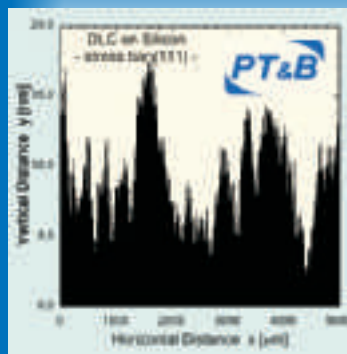
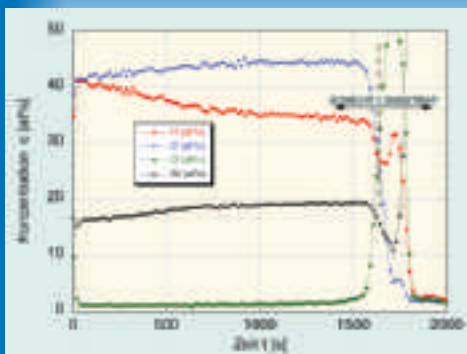
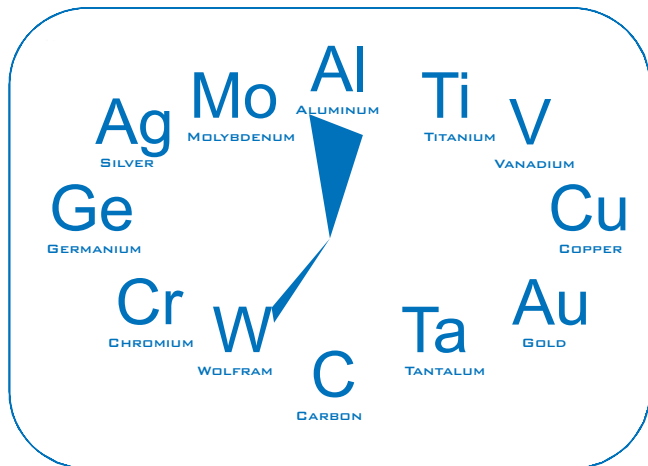
A variety of daily life's useful and necessary things is realized by thin film coatings. A relaxing movie night at home – LCD screen, blue-ray disc and a bag of crispy chips – who cares about plasma, vacuum and coatings? Also the next generation technology will demand for coatings.

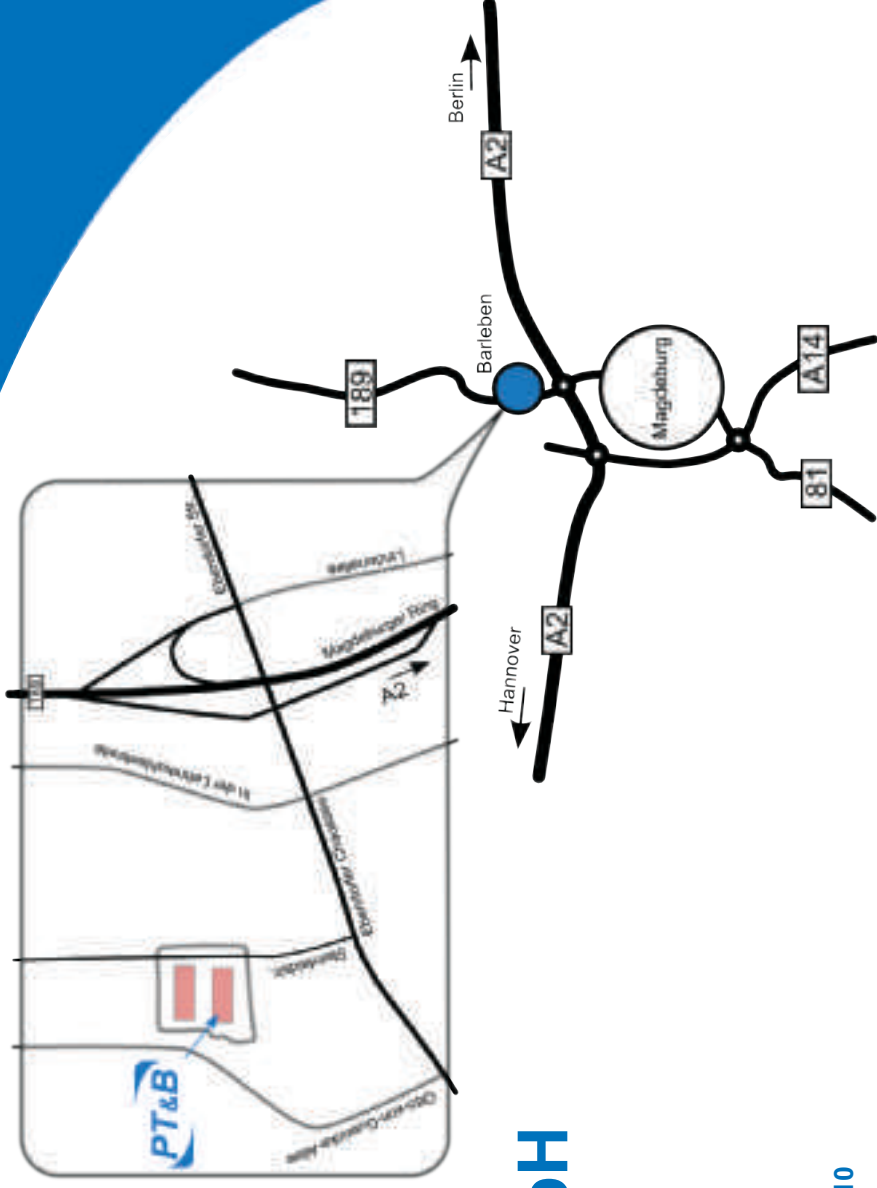
Therefore, PT&B SILCOR GmbH had launched R&D projects contributing to automotive mobility without combustion engines and electrical energy from solar irradiation.

A team of well-educated physicists works on these projects. They had acquired a broad academic training for a solid knowledge of the physical and chemical processes of coating. This in combination with the experience of a long-term practical work enables them to choose from a variety of novel solutions for technologies and coatings.

Research and development at PT&B SILCOR GmbH is guided by striving for simple, reliable solutions, which supply economical coatings with high use for the customers.

Ideally, the co-operation with our clients starts in an early stadium of product development defining the properties of the coating. In the case that none of the coatings from the portfolio of PT&B can fulfill these requirements, coatings have to be modified or newly developed. This way the customers of PT&B SILCOR obtain an optimum coating for a leading product.





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