



Fraunhofer

IWS



Dresden

FRAUNHOFER-INSTITUT FÜR WERKSTOFF- UND STRAHLTECHNIK IWS



spARC®-MODULE FOR THE DEPOSITION OF SUPER HARD CARBON LAYERS

Industrial process for the cost-effective coating of tools and assembly parts

Fraunhofer-Institut für Werkstoff- und Strahltechnik IWS

Fraunhofer-Projektgruppe im DOC
Dortmunder OberflächenCentrum
Eberhardstraße 12, 44145 Dortmund,
Germany

Fax +49 231 844-6025
www.iws.fraunhofer.de/doc

Contact:
Dr. Teja Roch
Phone +49 231 844-3894
teja.roch@iws.fraunhofer.de

Motivation

The layers of tetrahedral bound, amorphous carbon (ta-C) developed at the IWS under the trade name Diamor® are, with a diamond bond content of up to 70 %, extremely hard and display a very low friction coefficient in both a lubricated and a dry state. They currently possess the highest potential for the reduction of wear and friction and are therefore being used increasingly in industrial applications. With the short pulsed Arc (spARC®), another robust process for the cost-efficient deposition of Diamor® is now available in addition to the Laser-Arc™ Technology as developed by the IWS.

Solution

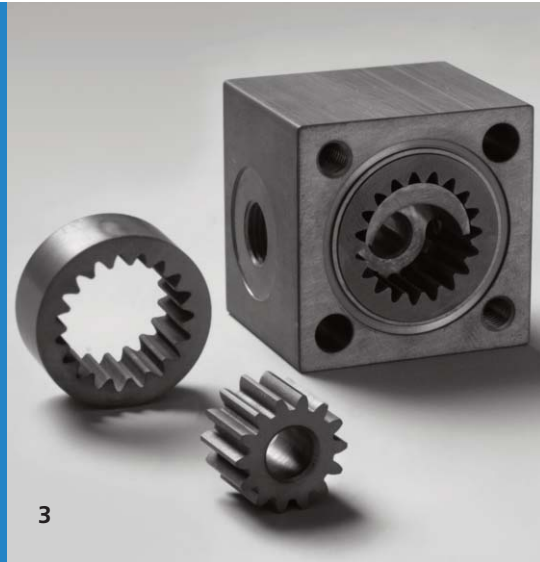
The spARC® represents a combination of the direct current vacuum arc (a process widely used in industry for the deposition of wear-resisting coatings) and short high current pulses. High current pulses with a pulse duration of 300 µs and a top current of approximately 1,550 A are superimposed on a continuously burning direct current arc with an arc current between 50 A and 100 A, and with a frequency of 100 Hz. These current pulses cause an increase in the energy of the layer-building carbon ions, thereby leading to a high diamond bond content in the layer. This means that layers with a hardness of approximately 4,500 HV can be deposited.



1



2

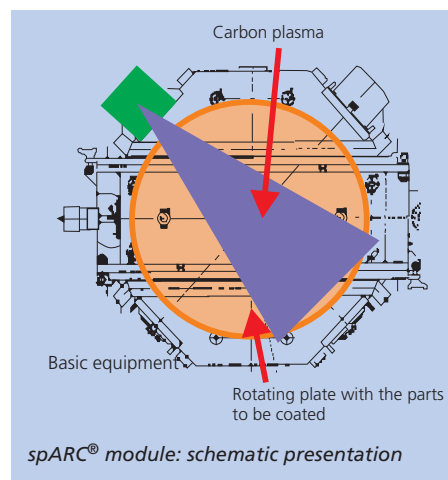


3

The spARC® Module

The spARC® module consists of an evaporation plate with the required number of evaporation sources, which can be adapted to a free flange on existing equipment. In addition, there are one to three cabinets – according to the number of evaporators – which contain the control mechanism, the direct current and the pulse current sources. The modular construction permits the straightforward upgrading of existing coating equipment with one to six evaporation sources, according to the size of the basic equipment. With three evaporation sources, for example, it is possible to attain a coating height of up to 800 mm, according to the requirements of the layer thickness homogeneity.

The simple, robust construction, which contains hardly any moving parts, makes for a high degree of reliability and smooth integration into existing equipment. In combination with the straightforward and cost-effective source technology and the high deposition rates, the process is very well suited to the cost-effective coating of tools and parts.



Applications

The spARC® module can be smoothly integrated into existing PVD equipment of different sizes as an extension unit with up to six evaporators. Using existing infrastructure, it permits the cost-effective deposition of super hard, tetrahedral bound, amorphous carbon layers with a high potential for the reduction of friction and wear.

Typical applications for such layers include tools for the machine processing of aluminum, copper, brass or CFK, where they reduce tool wear and the formation of built-up edges. They are suitable for the coating of cutting tools (knives and scissors, hand-operated or machine-operated) and of tools for the forming of metal, in particular for the forming of materials tending to fretting such as stainless steel, galvanized steel and aluminum, copper. The coating of assembly parts in friction and slide pairings is also advantageous, especially in the case of deficient lubrication or where lubrication is not permitted (e.g. pharmaceutical and food industry).

Technical data of the Diamor® deposition using spARC®

Direct current:	50 A up to 100 A
Pulse arc current:	1,550 A
Pulse length:	0.25 ms up to 0.3 ms
Working frequency:	100 Hz
Deposition rate in triple rotation:	2 $\mu\text{m h}^{-1}$
Deposition medium:	high vacuum ($p \approx 10^{-3}$ Pa)
Deposition temperature:	under 150 °C

Technical data of the Diamor®-layers

Hardness:	40 - 70 GPa
E-module:	400 - 600 GPa
Friction coefficient (lubricated):	< 0.05
Thermal stability:	400 °C (air), 650 °C (vacuum)

1 Process image of coating using the spARC® Technology

2 spARC® coating chamber equipped with tools

3 Al cog pump coated with Diamor® for the supply of liquids