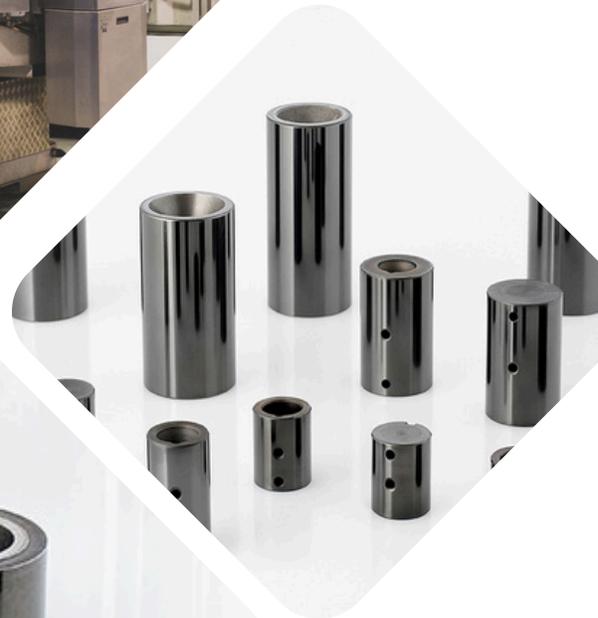
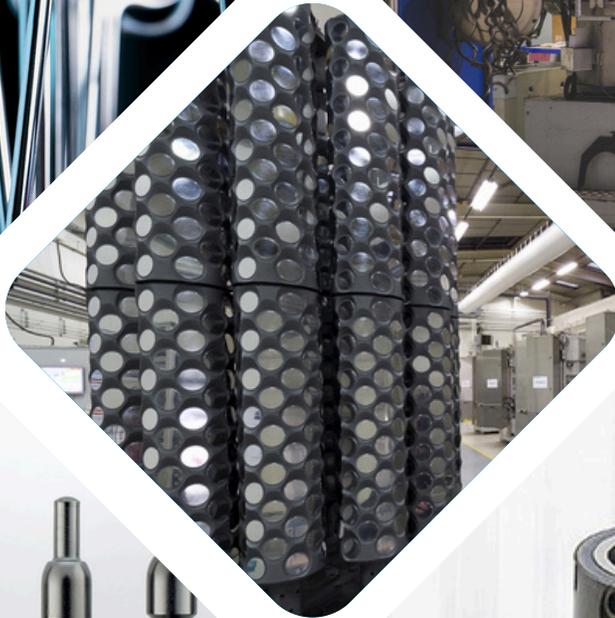


HEF[®]

NORTH AMERICA | Surface materials engineering

Diamond-like-Carbon (DLC) Tribological coatings

Certess Carbon DDT. DT. DCX. DCY. DCZ. TC.



PVD Coatings Overview

Physical Vapor Deposition (PVD) coating involves the deposition of thin (2-10 microns; 0.0001"-0.0004") films on the surface of components. The PVD coating process, conducted under high vacuum conditions, can be divided into three stages:

- **Evaporation** - Removal of material from the target, source or cathode. Material is usually extracted from a high purity solid source, such as Titanium, Chromium etc., by sputtering or by an arc-discharge.
- **Transportation** - Travel of evaporated material from the source to the surface of the component to be coated. The transportation step is through a plasma medium. Plasma is a collection of charged particles (ions), whose constituents can be influenced by magnetic fields and tend to travel in straight lines or "line of sight" from source to substrate. Different characteristics are imparted to the plasma depending upon the technique used to generate it.
- **Condensation** - Nucleation and growth of the coating on the component surface. A PVD coating is formed when plasma constituents and reactive gases, such as nitrogen, combine on the component surface to form thin and very hard coatings such as Titanium nitride (TiN) and Chromium nitride (CrN).

The properties of the PVD coating depend up-on: ion energy; the degree of ionization of the metal ions; and mobility of the atoms condensing on the component surface.

Attributes of PVD Coatings

**Hardest
(1500 -4500 HV)**
known synthetic materials size
tolerance

Thin (2 to 5 microns)
coatings minimal impact on size
tolerance

**Low coating temperature
(150-250° C)**
no distortion or core hardness loss

**Low friction coefficients
(0.1-0.5)**
minimize friction losses

Line of sight process
difficult to coat cavities or IDs

**High Adhesion to a
wide range**
minimize coat cavities or IDs steels, copper-
alloys, plastics, glass

Ability to deposit
**alloyed and multi-layered
coatings**

Possible to mask regions
on component where no coating is
desired

Zero environmental impact
no effluents or toxic chemicals

DLC Coatings

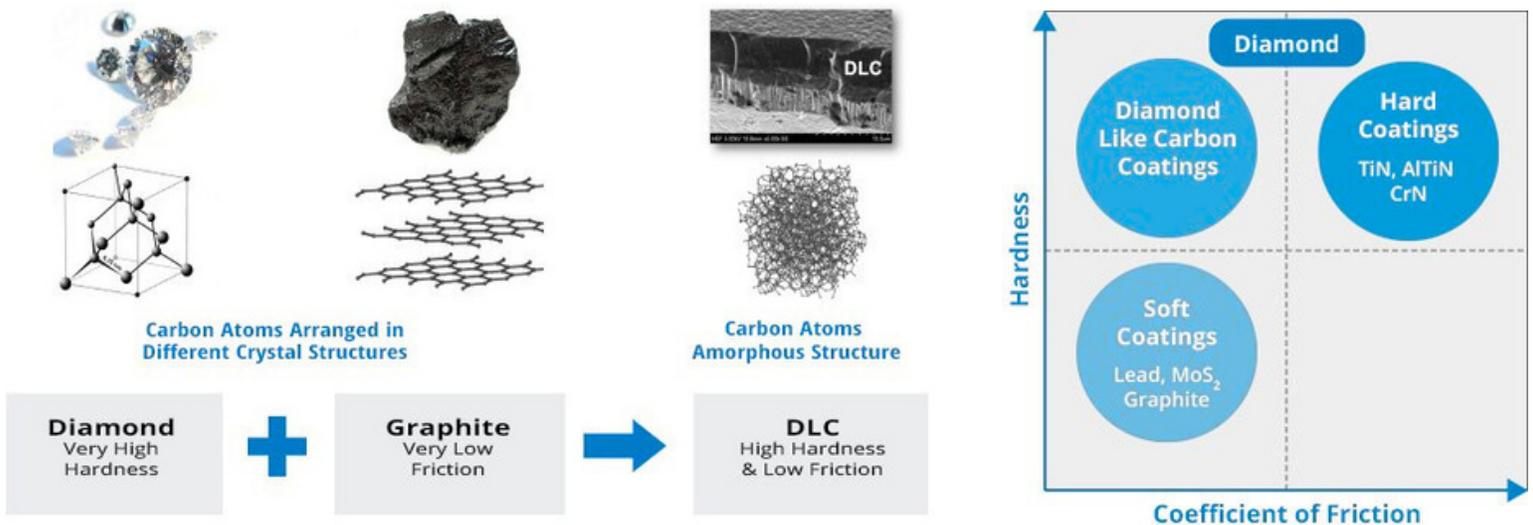
In recent years, a new generation of PVD + PACVD (plasma-assisted CVD) coatings has gained wide-spread commercial success. As is well known, in nature carbon can exist in two allotropic forms. Carbon, in a **Diamond** crystal structure, is one of the hardest know materials. Carbon, in a **Graphite** crystal structure, is very soft and lubricious. Carbon-based coatings, referred to as

Diamond-like-Carbon

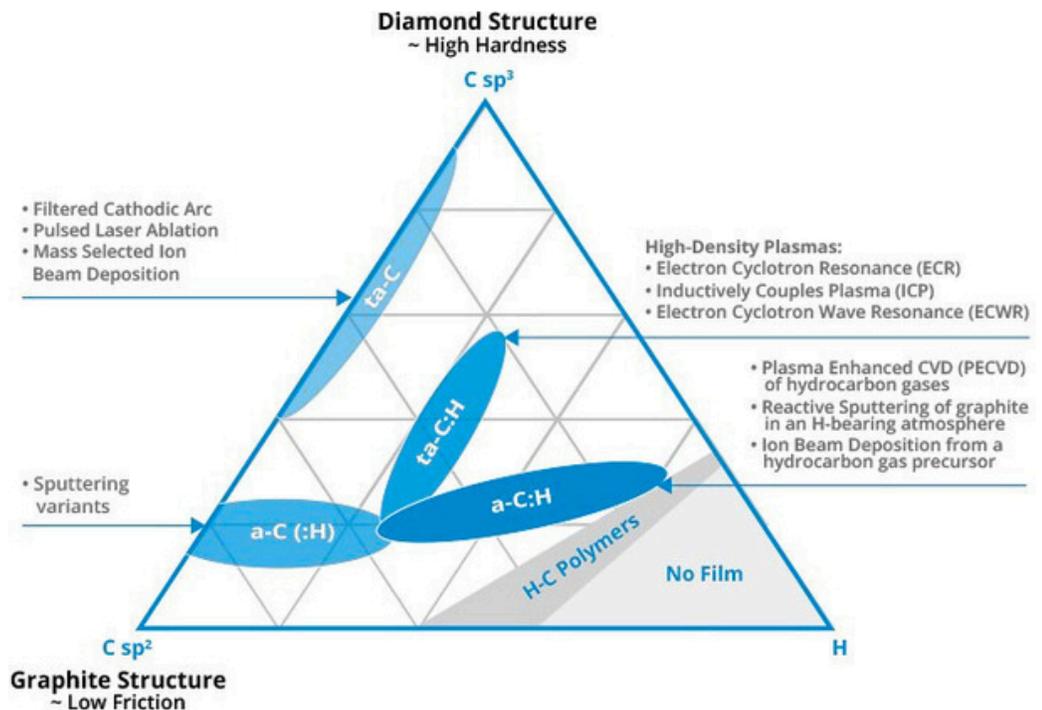
(DLC) coatings, combine these two different properties of diamond and graphite - hence possess high hardness levels - in the range of conventional tribological PVD coatings (1500 - 3200 HV), coupled with a coefficient of friction which is 200-500% lower than that of conventional PVD coatings.

These DLC coatings are generally amorphous (without a regular crystal structure) in nature.

What is a Diamond-Like-Carbon (DLC) Coating?



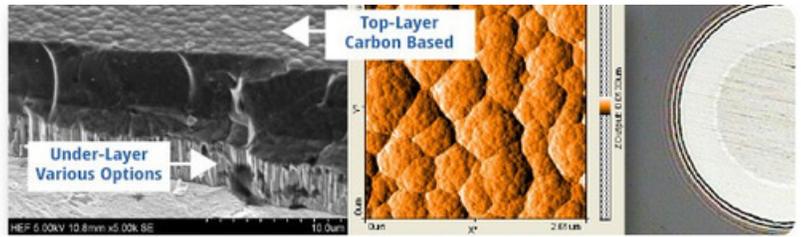
DLC coatings can be deposited using a diverse range of technologies and alloyed with elements such as hydrogen and metals such as chromium. These constituent elements and deposition technique can have a significant impact on the properties and structure of the DLC coating.



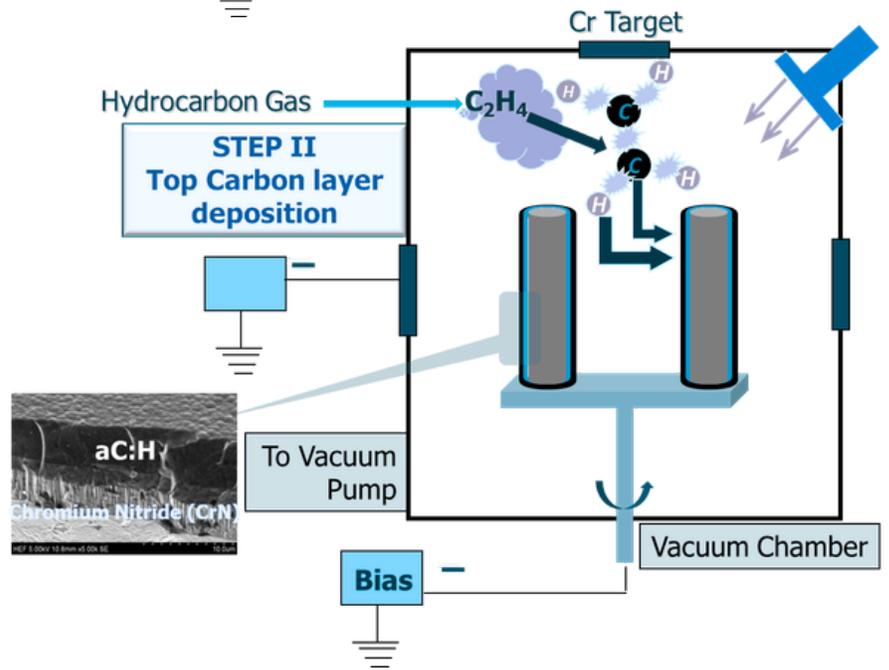
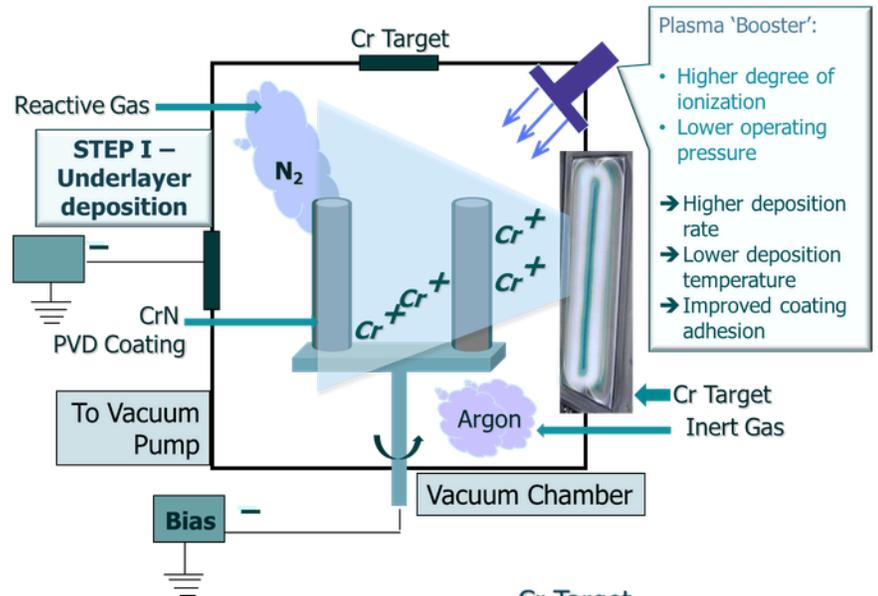
DLC COATING DEPOSITION:

Simplified, Schematic view HYBRID PVD – PACVD deposition (CrN – aC:H)

In order to meet the diverse operating conditions encountered by medical & dental instrument and implant applications, HEF has developed a family of diamond-like-carbon DLC coatings. These coatings usually include several layers of different materials such as **Cr, CrN, W, WC-C, Si** with a top layer of amorphous carbon, with hydrogen. The selection of the under-layer is based upon several factors such as: adhesion requirements, wear mode and contact mode, friction regimes encountered during operation, load carrying capacity, and other metallurgical considerations.



Topography of the top carbon layer depends on the morphology & and structure





CERTESS™ LIFE DLC COATINGS						
Coating	Composition	Friction Coefficient (Dry against steel)	Friction Coefficient (Lubricated)	Hardness (Hv)	Coating Thickness (microns)	Deposition Temperature °C
CERTESS™ CARBON DC	a-C:H	0.11 – 0.15	0.07 – 0.11	2000 - 2500	2 – 5 µm but can vary depending on the application	150 - 350 °C but can vary depending on the application
CERTESS™ CARBON DDT	WC + a-C:H:W + a-C:H	0.11 – 0.15	0.07 – 0.11	2500 - 3200	2 – 5 µm but can vary depending on the application	150 - 350 °C but can vary depending on the application
CERTESS™ CARBON DCX	CrN + a-C:H	0.11 – 0.15	0.07 – 0.11	2500 - 3200	2 – 5 µm but can vary depending on the application	150 - 350 °C but can vary depending on the application
CERTESS™ CARBON DCY	Cr + WC + a-C:H:W + a-C:H	0.11 – 0.15	0.07 – 0.11	2500 - 3200	2 – 5 µm but can vary depending on the application	150 - 350 °C but can vary depending on the application
CERTESS™ CARBON TC	ta-C	< 0.1	< 0.1	3000 - 7000	1 – 4 µm but can vary depending on the application	150 °C

Diamond-Like-Carbon (DLC) Coating Properties

The properties of DLC coatings in terms of hardness; coefficient of friction; roughness; adhesion level; load carrying capacity; resistance to humidity influenced degradation; fatigue tolerance, etc. can be tailored over a wide range depending upon deposition parameters, deposition technology and the combination of materials constituting the coating.



Automotive Components

- Piston Pins
- Piston Rings
- Rocker Arm Pin
- Valve Tappet
- Rocker Arm

Industrial Gears & Mechanical Seals

- Pump Gears
- Timing Gears
- Transmission and Differential Gears



Motion & component holding & transfer mechanisms

- Rails & guides
- Sprockets
- Links
- Spindles
- Collects
- Clamping Devices



Medical Instruments & Devices

- Prosthetic devices
- Bone screws and plates
- Surgical instruments and tools Cardiovascular
- Dental implants



Compressor Components

- Vanes
- Swash Plates
- Aerofoils
- Impellers
- Reciprocating Piston Plungers



Hydraulic & Pneumatic equipment

- Gate
- Ball
- Needle and Butterfly valves
- Seals
- Seats
- Stems
- Balls
- Glands
- Actuator sub-components



Plastic Injection Molding Dies

HEF NA Tribology Sites

HEF Group offers innovative solutions for wear, friction and corrosion reduction through a diverse selection of surface treatments and hard coatings. We partner with the industry's largest and most demanding manufacturers to develop application-specific surface engineering processes that substantially enhance performance and long-term durability.

HEF is currently active in more than 21 countries throughout Europe, Asia, and the Americas and has over 90 operating facilities. Our primary jobbing service offerings include the following:

Application Engineered Liquid Nitriding: ARCOR[®], MELONITE[®] / QPQ Treatments
State-of-the-Art PVD & PECVD Technology Used to Deposit PVD & DLC Coatings

Located in:

Ohio, Maine, Tennessee, Michigan, Arizona, North Carolina, New York

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