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FRAUNHOFER INSTITUTE FOR SURFACE ENGINEERING AND THIN FILMS IST

1 *Gear wheels coated with diamond-like carbon DLC.*

2 *DLC-coated bucket tappets in the engine: reduction of friction and fuel consumption.*

DIAMOND-LIKE CARBON COATINGS (DLC)

Amorphous diamond-like carbon coatings (DLC) are wear-resistant and low-friction. DLC coatings are deposited by PACVD or PVD processes.

Depending on the manufacturing process, deposition conditions and composition the properties of the coatings can be precisely set within a wide range. In recent years this broad scope of variation in coating properties has resulted in a series of different carbon coatings with diverse applications.

The combination of high wear resistance with outstanding frictional and non-stick properties makes DLC coatings an ideal surfacing solution for tribologically stressed components and tools.

The Fraunhofer IST tailors DLC coatings precisely to the individual application. High-performance products with multifunctional surfaces and new properties are thus created.

Properties and advantages

- Deposition temperatures < 200 °C
- Typical coating thicknesses: 1 µm to 10 µm
- Low coefficients of friction (COF)
- High wear resistance
- High level of hardness coupled with above-average high elasticity (E/H ≈ 10)
- Non-stick properties possible
- Adjustable electrical conductivity
- Coating material is corrosion-resistant
- Can be deposited onto most materials

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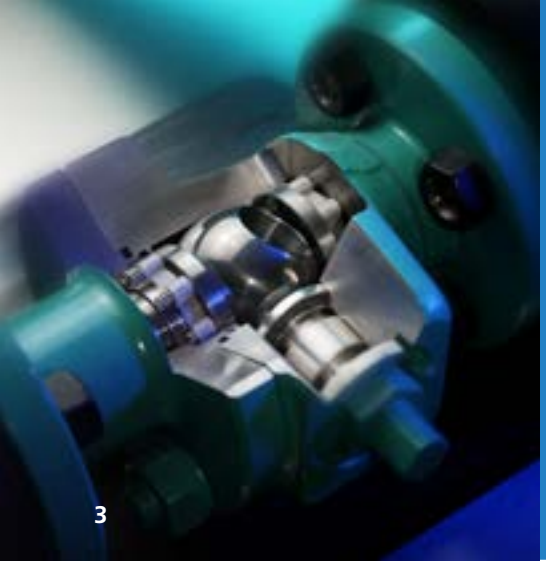

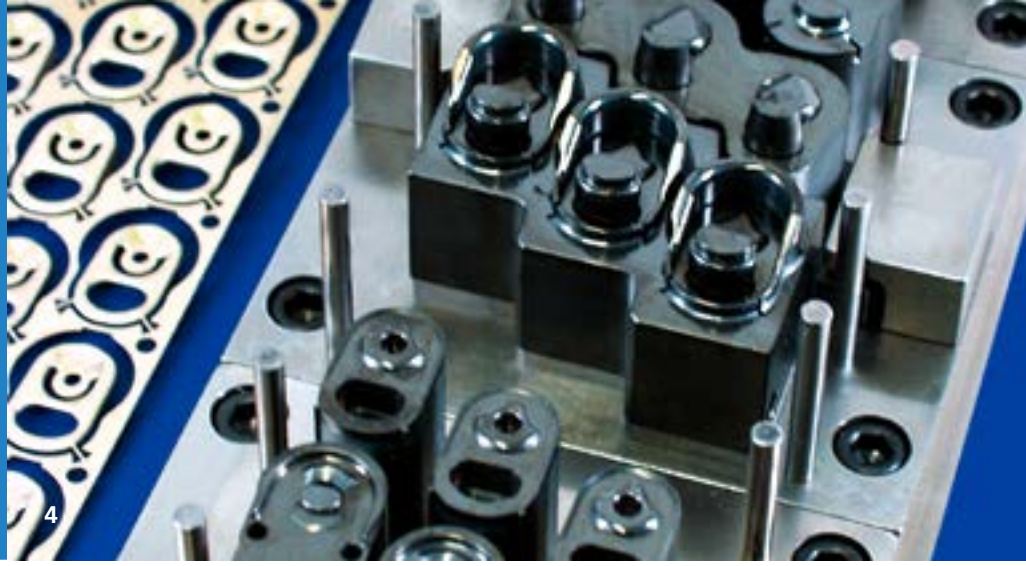

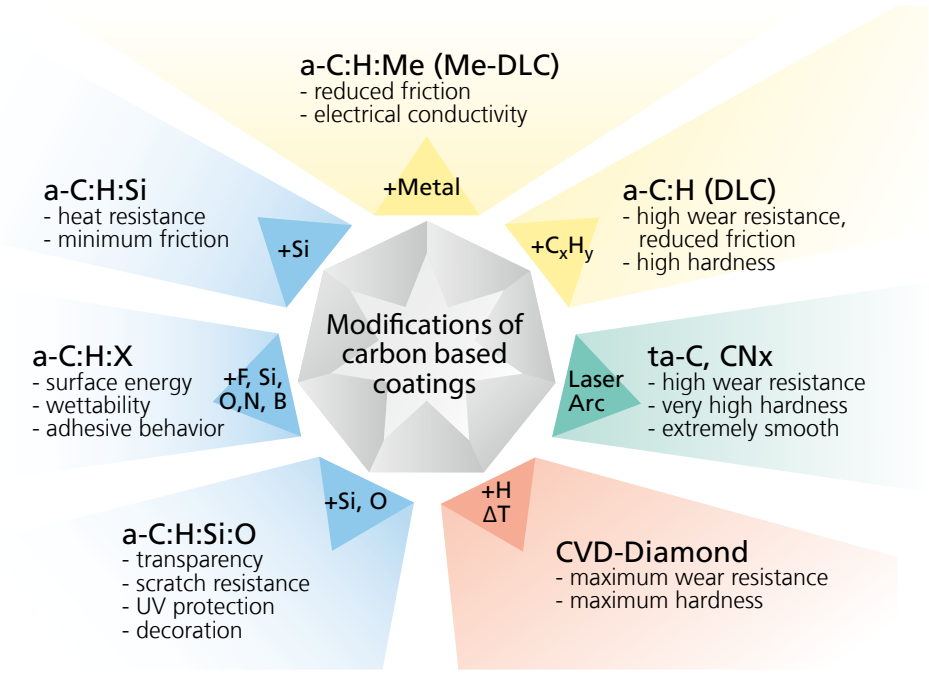

Propperties of different carbon coatings available at Fraunhofer IST in comparisson to uncoated steel

Hardness [HV]	Wear [dry against Al_2O_3 (m^3/Nm)10-15]	COF [dry friction steel]	Surface energy [mN/m]	Heat res. in air [°C]
a-C:H (DLC)				
2000–4000	0.5–1	0.10–0.20	35–40	400
a-C:H:Me (metal variants)				
1000–1800	2–10	0.15–0.20	40–45	400
a-C:H:Si (SICAN)				
1000–1800	8-10	0.07–0.15	30–35	500
a-C:H:Si:O (SICON®)				
600–1000	15–40	0.50–0.60	22–26	500
Diamond				
approx. 10000	none	approx. 0.10	35–65	600
100Cr6 steel, hardened				
approx. 800	approx. 220	0.70-0.90	> 1000	loss of hardness above 200 °C

Applications

Machine elements:

- Drive elements,
  such as gear wheels, shafts, axles, chains
- Sealing elements,
  such as face seals, ball valves
- Bearing elements,
  such as plain bearings, ball bearings, guide elements
- Piston/cylinder pairs,
  such as shock absorbers, pistons for engines, pumps, compressors

Tools:

- Molding tools,
  such as diecasting molds
- Forming tools,
  such as deep-drawing dies
- Cutting and stamping tools
- Pressing tools,
  such as punches, die-plates

3 *Coated ball valve: reduction in input power.*

4 *Coated deep-drawing tools: prevention of galling.*

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