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
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

Properties of different carbon coatings available at Fraunhofer IST in comparison to uncoated steel

<table>
<thead>
<tr>
<th>Hardness [HV]</th>
<th>Wear [dry against Al₂O₃ (m³/Nm)^1/2]</th>
<th>COF [dry friction steel]</th>
<th>Surface energy [mN/m]</th>
<th>Heat res. in air [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>a-C:H (DLC)</td>
<td>2000–4000</td>
<td>0.5–1</td>
<td>0.10–0.20</td>
<td>35–40</td>
</tr>
<tr>
<td>a-C:H:Me (metal variants)</td>
<td>1000–1800</td>
<td>2–10</td>
<td>0.15–0.20</td>
<td>40–45</td>
</tr>
<tr>
<td>a-C:H:Si (SICAN)</td>
<td>1000–1800</td>
<td>8–10</td>
<td>0.07–0.15</td>
<td>30–35</td>
</tr>
<tr>
<td>a-C:H:Si:O (SICON®)</td>
<td>600–1000</td>
<td>15–40</td>
<td>0.50–0.60</td>
<td>22–26</td>
</tr>
<tr>
<td>Diamond</td>
<td>approx. 10000</td>
<td>none</td>
<td>approx. 0.10</td>
<td>35–65</td>
</tr>
<tr>
<td>100Cr6 steel, hardened</td>
<td>approx. 800</td>
<td>approx. 220</td>
<td>0.70–0.90</td>
<td>&gt; 1000</td>
</tr>
</tbody>
</table>

3 Coated ball valve: reduction in input power.

4 Coated deep-drawing tools: prevention of galling.