TRANSPARENT, SCRATCH-RESISTANT LAYERS ON LARGE AREA SUBSTRATES

Technology

- High-rate electron beam evaporation
- Plasma-activation by hollow cathode arc discharge (HAD process)
- Organic modification by combination with PECVD
- High deposition rates on large areas (50 ... 600 nm/s)
- High productivity – low cost
- Low thermal load (plastic, e.g. PC, max. temperature < 130°C)
- Wet chemical cleaning of metals prior vacuum processing
- (Pulse) plasma pre-treatment
- Technology development to customized requirements
- Pilot production for metal strips, plastic films (300 mm width) and large sheets (500 mm x 500 mm) in large scale pilot plant MAXI

Applications

- Kitchen
- Indoor interior
- Architecture
- Automotive
- Rail-bound transportation
- Lighting
- Solar thermal absorber
- Photovoltaic

Substrates

- Materials:
  - Plastics (e.g. polycarbonate),
  - Metals (e.g. stainless steel),
  - Glasses (e.g. float glass),
  - Ceramics (e.g. tiles)
- Shape:
  - Small, medium size and large area flat substrates (sheets, strips, films)
  - Simple shaped 3D substrates
Characteristics

General:
Transparent, scratch-resistant layers on large area substrates from plastics, metals, glasses and ceramics.

The optical appearance of the surface will not be altered by coating.

Layers:
- Silica based (SiO_2) and alumina based (Al_2O_3) coatings
- Thickness 1 … 10 µm
- Organic modification by incorporation of carbon
- Improved elasticity
- Incorporation of nano-crystalline Si in the SiO_2 layer matrix for extremely high hardness

Mechanical properties:
- High hardness (2 … 15 GPa) compared to substrate (see table)
- High abrasion resistance (see graph, fig. 7)
- Excellent adhesion, even in the presence of moisture (plastic substrates)
- Low internal stress
- Elastic and plastic deformability up to 3%
- Stability against temperature cycling
- High corrosion resistance
- Low finger print sensibility

Optical properties:
- High transparency (k: 0.001 ... 0.01 @ 550 nm)
- High uniformity of layer thickness

### Hardness of substrates and abrasion-resistant SiO_2 layers

<table>
<thead>
<tr>
<th>Substrate</th>
<th>Hardness of the substrate [GPa]</th>
<th>Hardness of the SiO_2 layers [GPa]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polycarbonate</td>
<td>0.11*</td>
<td>2 … 3</td>
</tr>
<tr>
<td>PET</td>
<td>0.15*</td>
<td>2 … 3</td>
</tr>
<tr>
<td>PMMA</td>
<td>0.18*</td>
<td>2 … 3</td>
</tr>
<tr>
<td>Ferritic steel (St 14)</td>
<td>1</td>
<td>8 … 15</td>
</tr>
<tr>
<td>High-alloy steel (X5 CrNi 18.10)</td>
<td>3 … 4</td>
<td>8 … 15</td>
</tr>
<tr>
<td>Float glass</td>
<td>ca. 6</td>
<td>8 … 10</td>
</tr>
</tbody>
</table>

Hardness measurement by nano-indentation; * Ball indentation

7 Transparent, hard (ca. 9 GPa) SiO_2 layers on glass substrates subjected to the Taber Abraser test. Parameters: Friction wheels CS-10F, 500 g load

We focus on quality and the ISO 9001.