Fraunhofer FEP

Fraunhofer Institute for Electron Beam and Plasma Technology FEP

Transparent, scratch-resistant layers on large area substrates

Indoor interior

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 × 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

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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_x) 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_x layer matrix for extremely high hardness

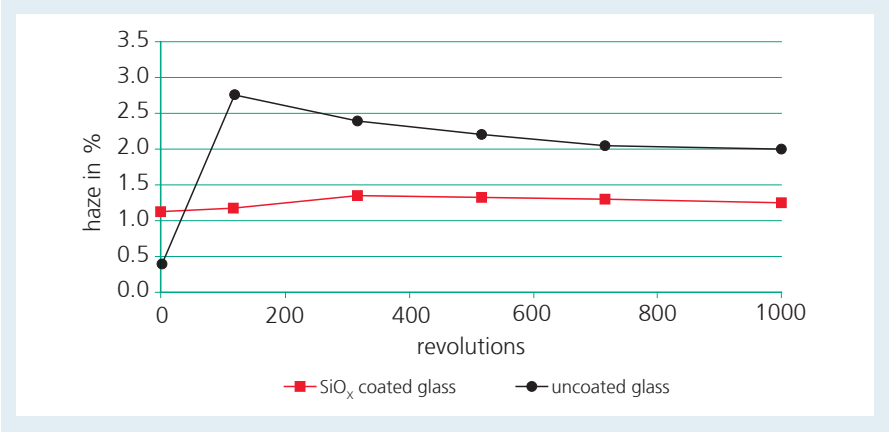
Mechanical properties:
- High hardness (2 … 15 GPa) compared to substrate (see table)
- High abrasion resistance (see graph, fig. 4)
- Excellent adhesion, even in the presence of moisture (plastic substrates)
- Low intrinsic layer stress
- Elastic and plastic deformability up to 3%
- Stability against temperature cycling
- High corrosion resistance
- Low fingerprint sensibility

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

Hardness of substrates and abrasion-resistant SiO_x layers

Substrate	Hardness of the substrate [GPa]	Hardness of the SiO_x layers [GPa]
Polycarbonate	0.11*	2 … 3
PET	0.15*	2 … 3
PMMA	0.18*	2 … 3
Ferritic steel (St 14)	ca. 1	8 … 15
High-alloy steel (X5 CrNi 18.10)	3 … 4	8 … 15
Float glass	ca. 6	8 … 10

*Hardness measurement by nano-indentation; * Ball indentation*



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

1 *Indoor interior*
2 *High abrasion resistance*
3 *Automotive*