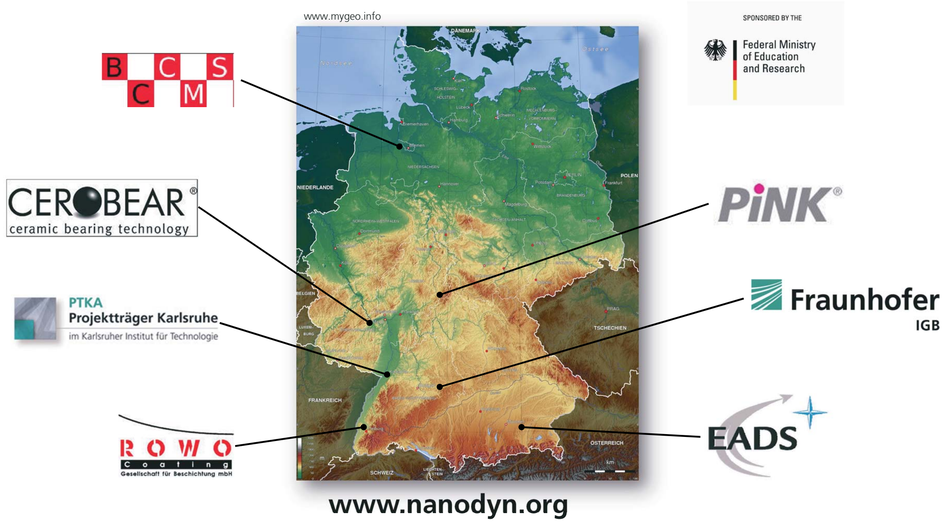

Plasma functionalization of foiles and technical textiles with specific tunable wetting behavior

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Motivation

Surface coatings on foils and textiles with excellent environmental durability are not available for high quality materials. Within the so called "nanodyn"-project (www.nanodyn.org) nanoscopic function layers on metallized and unmetallized polymer films and textiles or nonwoven web materials are developed. The objectives of the sub-project are the development of stable, corrosion and abrasion resistance surfaces on foils and textiles with specific wettability.

Architecture, clothing and electronic application examples

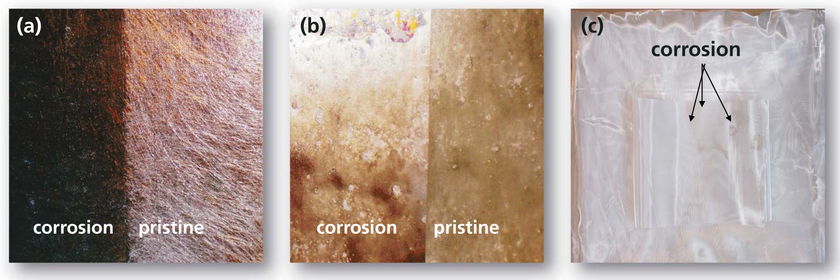


Figure 1: Examples of metallized surfaces after corrosion tests: (a) copper coated nonwoven, (b) gold-like wall paper, and (c) silver coated nonwoven without protective coating.

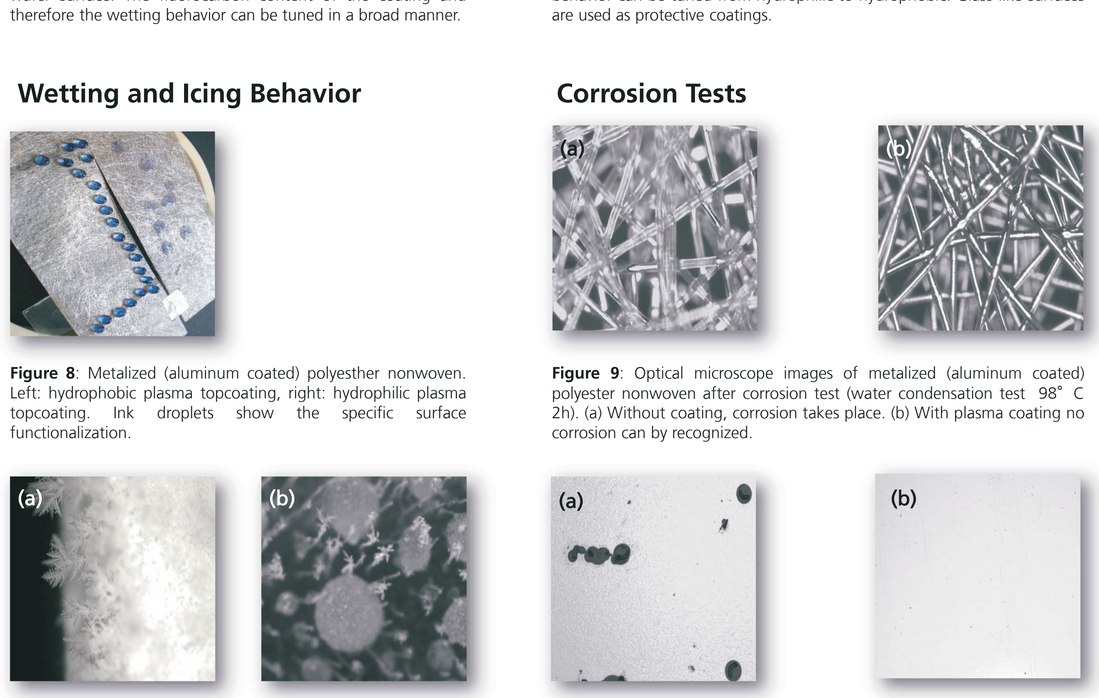
Results

Surface Functionalization

Different surfaces of polymer foils or textiles are under investigations. Much potential lies in the specific chemical and physical functionalization of these surfaces. Thin pp-HMDSO/SiOx (> 10 nm) and ultra thin (< 5 nm) fluorocarbon nanostructured-layers are developed by plasma polymerization on surfaces for specific tunable wetting behavior or protective coatings.

Figure 2: Plasma reactors:
(a) roll coater with 1.60 m treatment width (ROWO),
(b) small lab reactor (Pink GmbH Thermosysteme).

Plasma Polymerization Process:



Test Methods

- adhesion: EN ISO 2409 (crosscut) before and after tests, objective: GT 0-1
- coatings must be stable in deionized and rain water, NaCl solution, suds, and acids (-> fingerprint stable)
- corrosion tests: condensation exposure (NaCl solution: 98° C, 1-4h)
- storage under high humidity (75° C, 95%, 48h)
- optical reflection of coated metallic surfaces after tests, aim: decrease <10%
- abrasion test: falling sand abrasion (DIN 52348), tape abraser (DIN 52347, DIN 68861)

Chemical Characterization (ESCA Analysis)

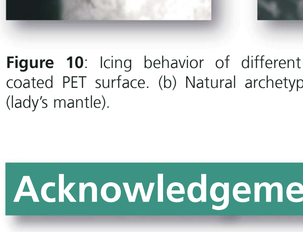


Figure 2: ESCA analysis of an ultra thin CHF_3 plasma coated Si-wafer surface. The fluorocarbon content of the coating and therefore the wetting behavior can be tuned in a broad manner.

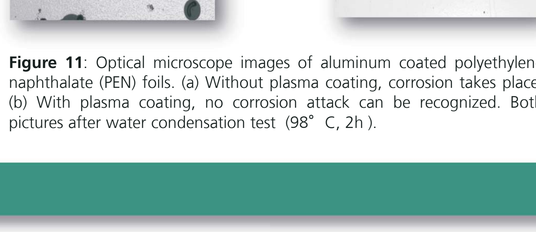


Figure 3: ESCA analysis of a HMDSO plasma coated surface. The wetting behavior can be tuned from hydrophilic to hydrophobic. Glass-like surfaces are used as protective coatings.

Contact Angle Measurements

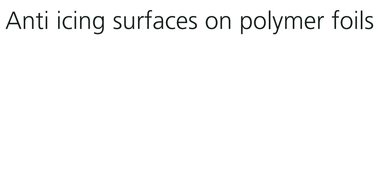


Figure 4: Left: hydrophobic, right: hydro-philic plasma coating of a textile.

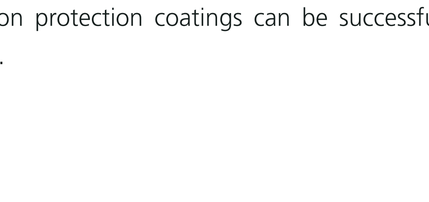


Figure 5: Water contact angle measurement of different plasma coatings on PU foils (anti-icing application for aircrafts or wind turbines).

Figure 6: Water contact angle measurement of a hydrophobic non woven (pristine) after different plasma coatings (objective: complete wettability, application humidity sensors).

Figure 7: Water contact angle measurement of PET foils before and after plasma coatings (objective: stable hydrophobic, surfaces).

Wetting and Icing Behavior

Figure 8: Metalized (aluminum coated) polyesther nonwoven. Left: hydrophobic plasma topcoating, right: hydrophilic plasma topcoating. Ink droplets show the specific surface functionalization.

Corrosion Tests

Figure 9: Optical microscope images of metalized (aluminum coated) polyester nonwoven after corrosion test (water condensation test 98° C 2h). (a) Without coating, corrosion takes place. (b) With plasma coating no corrosion can by recognized.

Figure 10: Icing behavior of different surfaces. (a) Plasma coated PET surface. (b) Natural archetype: icing of *Alchemilla* (lady's mantle).

Figure 11: Optical microscope images of aluminum coated polyethylene naphthalate (PEN) foils. (a) Without plasma coating, corrosion takes place. (b) With plasma coating, no corrosion attack can be recognized. Both pictures after water condensation test (98° C, 2h).

Summary

With different plasma coatings it is possible to functionalize many materials like polymer foils or textiles, and to adapt their functionality to their applications. The wettability can be tuned over a broad range by plasma topcoatings and corrosion protection coatings can be successfully applied. Anti icing surfaces on polymer foils are developed.

Acknowledgement

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