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Nicely Packaged and Well Protected

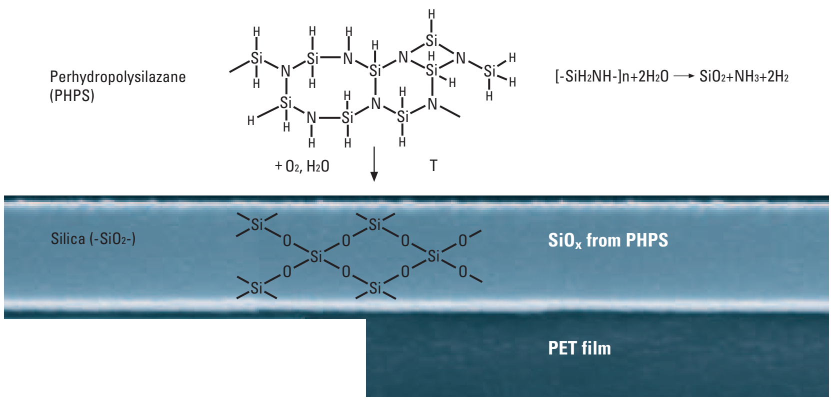
Innovative Films with a Gas Barrier

Polysilazanes for Individual Film Coatings

Packaging counts. A product – or person – that looks good simply has better chances of success. An attractive appearance is a great start. However, packaging films have to do far more. To start with, they have to be transparent, flexible and lightweight. If they are to be used as special packaging for food or flexible electronic components, moreover, they also have to protect against oxygen and water vapor.

The polysilazane-based film coatings from Clariant accomplish all of this and more. The ultrathin coatings for PET films achieve an outstanding gas barrier effect. They effectively protect products against gases such as oxygen and water vapor. Comparable barrier values are achieved only by non-transparent metallized films or PET-aluminum-polyethylene composites.

Polysilazanes are polymers with a structure containing silicon, nitrogen, hydrogen and in some cases carbon. They can be furnished with an individual profile of very different properties. They already react with the moisture in the air at ambient temperature and pressure to form dense, ultra-thin polysiloxane layers adhering firmly to the substrate. Especially dense layers are achieved by using inorganic perhydropolysilazane (PHPS).



Comparison with other coating systems

The superior properties of polysilazanes are especially noticeable in any direct comparison with other transparent coating materials achieving comparable effects, e.g. sol-gel systems or silica layers applied via various vacuum methods (e.g. chemical vapor deposition, CVD; physical vapor deposition, PVD).

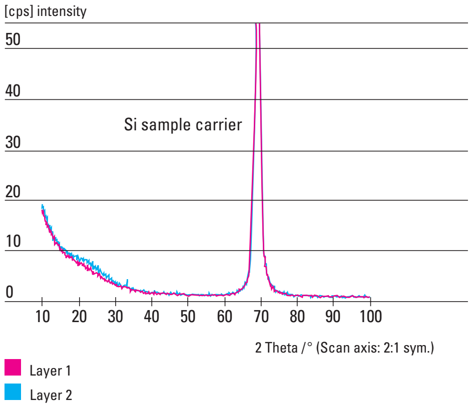
Among their other advantages, PHPS-based coatings have a markedly lower susceptibility to crack formation and shrinkage. This is because their molecular weight rises during the conversion of PHPS to silica, owing to their reaction with air moisture; this results in a larger ceramic yield. During the curing process of sol-gel layers, in contrast, alcohol or water is released, resulting in a lower molecular weight.

Moreover, PHPS layers form a distinctly dense silica structure, which is the main reason for their good barrier properties. Furthermore, PHPS coatings already cure at low temperatures and adhere extremely well to the substrate.

The manufacturing costs for polysilazane-based coatings are comparable to those for sol-gel systems. However, since the polysilazanes create much thinner layers, less material is used. In contrast, the complicated process of applying a silica coating using the CVD or PVD method is very cost-intensive.

X-ray diffraction diagram

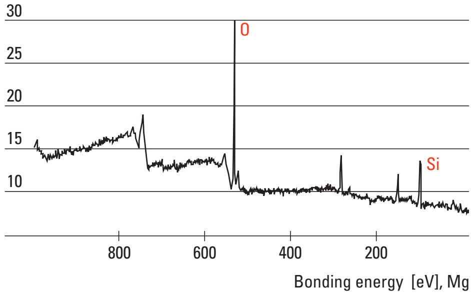
of two hardened PHPS coatings on a Si substrate



The x-ray diffraction diagram shows the glass-like structures with no crystalline zones.

ESCA spectrum of a hardened PHPS layer

[kCps] intensity



Electron spectroscopy for chemical analysis: composition of the PHPS-based silica layer consisting of silicon and oxygen.

Outstanding barrier functions

PHPS-based silica layers constitute an effective barrier against oxygen, water vapor and carbon dioxide. The water vapor transmission rate (WVTR) of a PHPS-coated PET film amounts to less than five percent of the WVTR of uncoated film. The oxygen transmission rate (OTR) is in fact less than one percent of the OTR of uncoated film.

Coating systems perform well in tests

Clariant commissioned the Institute for Surface Modification (IOM) in Leipzig, Germany, to test its PHPS-based coating systems for PET films. Owing to its high reactivity, a polysilazane should be first dissolved in a non-polar solvent (e.g. xylol or dibutylether). An immersion method is used to coat the films. The solvent is subsequently removed via thermal treatment with infrared radiation. VUV radiation is then used to convert the newly created PHPS layer, via oxidation, into a thin flexible silica layer in the submicrometer range.

Transmission of water vapor and oxygen

Sample	OTR at 0% rel. hum. / cm^3 m^{-2} d^{-1} bar^{-1}	WVTR at 90% rel. hum. / g m^{-2} d^{-1} bar^{-1}
23 µm PET, uncoated	80 – 90	20 – 22
23 µm PET + PHPS layer	0,3 – 1,0	0,8 – 1,0

Per square meter, day and bar: oxygen transmission rate at 0% relative humidity per cubic centimeter; water vapor transmission rate at 90% relative humidity per gram

Comparison of PHPS-coated and untreated PET film (23 µm thick).

PET film coating at a pilot plant.

We'll gladly keep you informed

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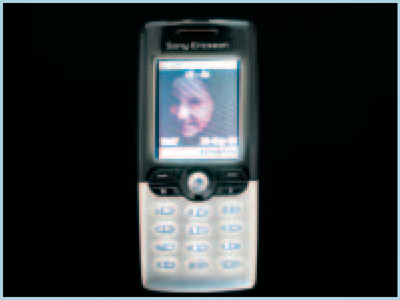
Coatings for Sophisticated Packagings



PET films with polysilazane-based coatings are especially suitable for packaging fresh food. Other possible applications are high-barrier layers for organic light-emitting devices (OLED), electronic components and flexible solar cells.

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Polysilazanes for Film Coatings

- create outstanding barriers against oxygen, water vapor and carbon dioxide
- cure at low temperatures
- form very thin layers (300 nm)
- are extremely flexible, stable and durable
- adhere excellently to carrier material
- can be furnished with a wide range of specific properties
- are economical and easy to process

To obtain further information and place orders, please contact us:

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