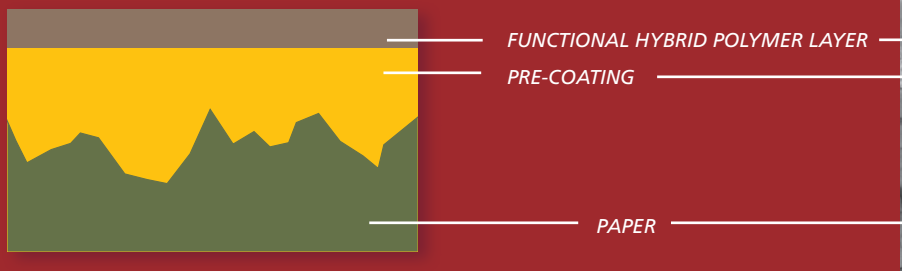
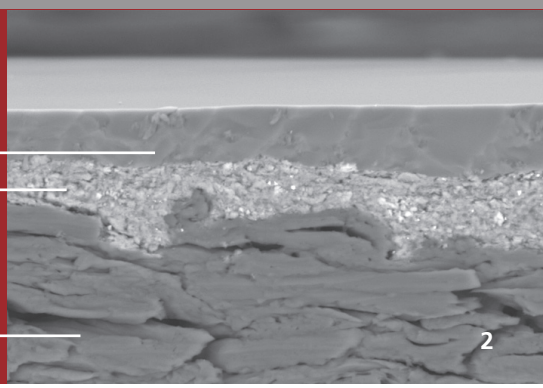
Fraunhofer
ISC

FRAUNHOFER INSTITUTE FOR SILICATE RESEARCH ISC



1



2

1 *Multilayer structure of envisaged functional paper for packages*
2 *Cross-section of a hybrid polymer layer (OR 2) applied onto the PTS-pre-coating; in this example a thicker layer was applied to achieve a perfectly visible layer structure (© PTS)*

Fraunhofer Institute for Silicate Research ISC

Neunerplatz 2
97082 Würzburg

Contact
Competence team
Hyprid Polymer Coating Materials

Dr. Sabine Amberg-Schwab
Phone +49 931 4100-620
sabine.amberg-schwab@isc.fraunhofer.de

www.isc.fraunhofer.de

FUNCTIONAL COATING SYSTEMS FOR PAPER

Paper is a low-cost printing and packaging material which is produced in large quantities and with reproducible properties. It meets all basic ecological requirements as it is manufactured from renewable raw materials, is easily recycled and biologically decomposable.

Despite their advantages paper and paperboards have been losing market shares to the plastics industry because as porous materials made of natural fibers, their inadequate barrier properties offer no protection against moisture, gases and vapors and are only suitable as packaging material when combined with synthetic polymers.

Up to now, in order to achieve this, plastics such as polyethylene are extruded onto the packaging papers or, more commonly, a plastic bag is inserted into the paper or paperboard packaging. In both cases the fairly large percentage of synthetic plastics hinders the recyclability.

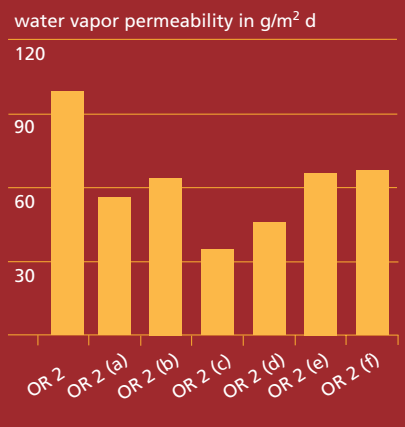
Enhancing the barrier properties

The Fraunhofer ISC's approach was to apply a functional coating system to improve the barrier properties against gases and water vapor – as well as the abrasion resistance – while saving the ecological advantages.

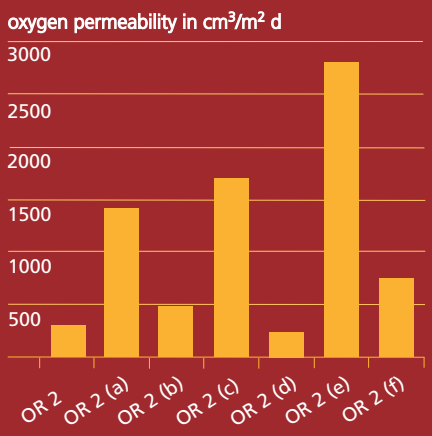
In contrast to well-known paper coatings like extrusion and wax coatings with over 15 µm in thickness, the new alternative coatings should only be 4 – 5 µm thick and insoluble in water. The coating must also be suitable for laminating with adhesives and for printing purposes.

Solution with pre-coating and hybrid nanocomposites

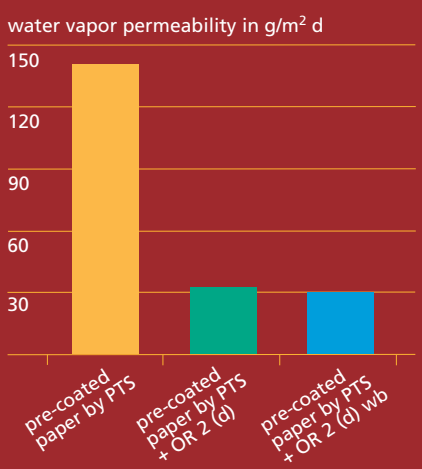
Most promising for a successful development of highly effective and thin barrier coatings on paper are inorganic-organic hybrid polymers (nanocomposites).



1



2



3

Applied onto polymer films they have already prov-en to provide good barrier properties in respect to the permeation of oxygen, water vapor and flavors. High abrasion resistance can be achieved additionally.

To achieve thin functional coatings on paper surfaces a paper pre-coating – e.g. on the basis of PVOH/clay – was combined with the hybrid polymer based coating. The pre-coating offers sufficient hold-out properties for the subsequent hybrid polymer systems and smoothens the paper surface. This enables the hybrid polymer layers to form thin but also dense layers on the paper surface (Figures 1 and 2).

Thermally as well as UV curable systems were investigated at the Fraunhofer ISC laboratory.

Results and conclusion

Six hybrid polymer coating systems were tested on seven different pre-coated state of the art paper types from Sappi Company and M-real. The concurrently lowest oxygen and water vapor permeabilities were obtained with the hybrid polymer type (OR 2) based on epoxy modified silanes and metal alkoxides in combination with a double coated silicone base paper (see Grafics 3 and 4). The abrasion resistance of the paper was also very much enhanced: according to DIN 53109 the initial 3 mg abrasion of the uncoated paper decreased to 0 mg abrasion for the coated paper.

Coated on a specially prepared paper with a pigmented pre-coating developed by PTS, the water vapor barrier was improved additionally by system OR 2 (d) (Grafics 3 and 4). The cross-section of such a coated paper sample illustrated that compact and smooth layers without any defects were achieved.

Since water based systems are of great interest for the paper industry, the alcohol based system was transformed to a water based system which exhibited comparable water vapor transmission rates (Grafic 5).

In combination with suitable pre-coatings 5 µm thin hybrid polymer layers provide better barrier properties and abrasion resistance than thicker state of the art paper coatings. The coatings can be applied to paper with the equipment commonly used in paper upgrading and they can be cured thermally as well as photochemically. In addition, they do not affect recycling processes, are overprintable and can be applied by roll-to-roll coating processes.

Extended range application for coated paper and paperboards

Coating paper with an extremely thin and highly functional hybrid polymer is a successful alternative for the ecologically less advantageous plastic films and paper/plastic laminates.

Conceivable applications are:

- Packaging for dry and non-greasy food, e.g. sugar, sweets, instant drinks, powdered soups
- Aroma-tight packaging for tobacco products (without need for plastic film wrapping)
- Packaging for washing powder

3 *Water vapor permeability (DIN 53122, gravimetric method, 23 °C, 85 % r. h.) of a silicone base paper coated with the hybrid polymer system OR 2 and the further optimized systems; permeability of the uncoated sample: 242 g/(m2 d)*

4 *Oxygen permeability (ASTM D 3985, 23 °C, dry gas) of a silicone base paper coated with OR 2 and optimized systems; no results available for uncoated sample since the upper measurement limits were reached (> 5000 cm³/(m² d))*

5 *Water vapor permeability of the alcohol OR 2 (d) and water based optimized hybrid polymer system OR 2 (d) wb, applied onto specially pre-coated paper developed by PTS (Papiertechnische Stiftung, Munich)*