

Properties of PBS

Barrier properties

PBS shows an intermediate behaviour between breathing polymers (showing both high water and oxygen permeability) and barrier polymers (showing both low water and oxygen permeability) such as PET and PEN.

Compared to PP, PBS is a lower water barrier but a much better oxygen barrier.

Compared to PLA, PBS has better oxygen and water barrier properties. This is attributed to its crystallinity.

Different materials have been studied, in order to establish the possibility to **modulate permeation properties through the formulation and through the polymer modification by copolymerization.**

Concerning the water permeability of PBS based materials, a factor 4 is observed between the (high) permeability of PBAT and the (low) permeability of Talc filled PBS.

Concerning the oxygen permeability of PBS based materials, a factor 10 is observed between the lowest permeability of PBAT and the highest permeability of Talc filled PBS.

The **improvement of barrier properties by the use of SiO_x coating** has been studied on different substrates and successfully on PBSA. A factor 10 is observed for the improvement of oxygen barrier properties while a factor 7 is observed for the improvement of water barrier properties.

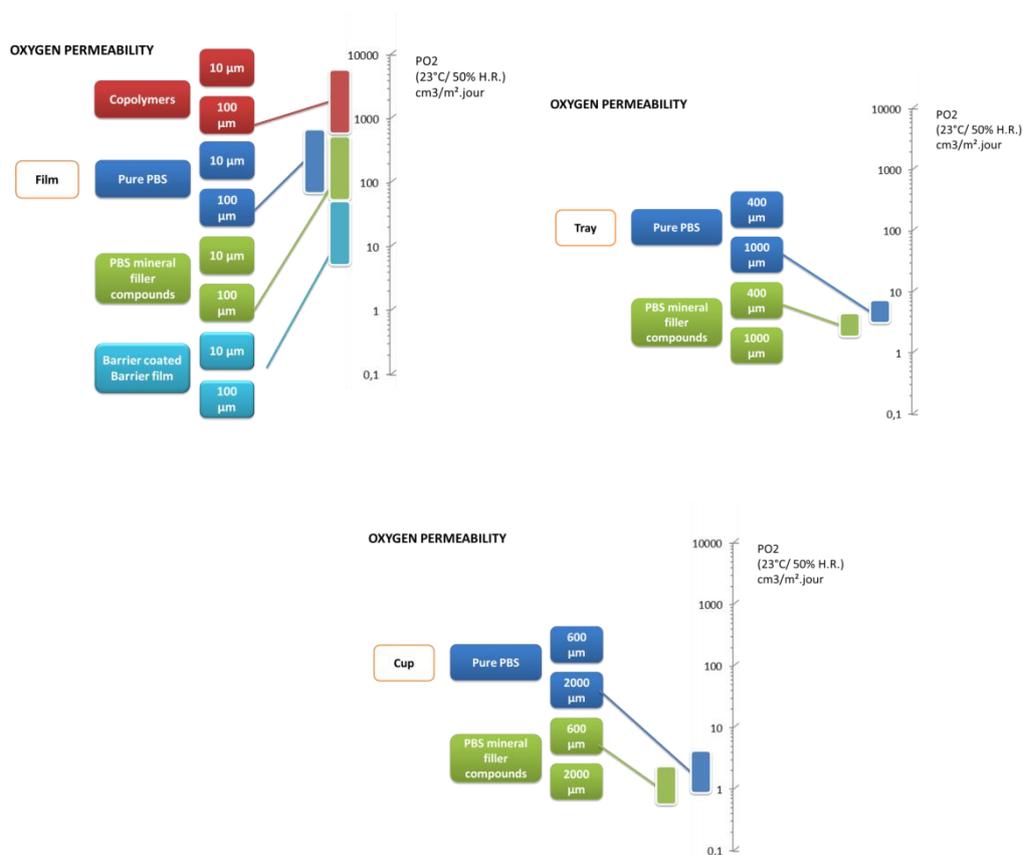
The improvement of barrier properties by hydrogenated carbon (**C_xH_y**) plasma treatment was studied by the 3D coating of PBS injected cups; no improvement was obtained, confirming that the plasma treatment (SiO_x or hydrogenated carbon) of pure PBS is technically difficult.

The improvement of permeability was then studied by green water based coatings. Two kinds of green water based coating were tested: TopScreen 30A1 (TopBrane) is a coating formulation that Topchim has developed to ensure a good oxygen barrier on flexible packaging. The transparent coating contains an immobilizer, polar pigments and a polar polymer. TopScreen DS3V is a coating formulation that Topchim has developed to ensure a good water vapour transmission barrier on flexible packaging. The transparent apolar coating contains a lamellar structured pigment with high aspect ratio.

With Topscreen DS3V a factor 4 was observed for the improvement of oxygen barrier properties while a factor 2 was observed for the improvement of water barrier properties. With the Topbrane coating, only water permeability is improved (factor 2)

The combination of the two types of coating leads to a good reduction of both oxygen and water permeability. Due to high water sensitivity, the oxygen barrier must be applied in the external part of the packaging to avoid migration issues and damage of the coating. The best combination of the coatings is then obtained with the oxygen barrier deposited on the external side of the packaging, and the water barrier on the internal side.

The improvement of permeability was finally studied by the modulation of packaging type and thickness. The permeability of a material is strictly inversely proportional to the sample thickness when the material structure does not vary with the thickness: barrier properties of films and thermoformed trays vary with the polymer orientation; concerning injected packaging the permeability varies with the crystallinity of the material. As a consequence, the change of the types of packaging leads to sensible variations of P_e/l (l sample thickness). **Permeation charts were built to select, from targeted water or oxygen permeability, the best PBS based packaging. The example below concerns the oxygen barrier properties.**



Oxygen permeability of films cups and trays

In a nutshell, a very large range of permeability can be accessed thanks to the types of formulation and sample thickness. The best flexibility is obtained with the films, with 3 decades of possible oxygen permeability.