Gas Barrier Coatings for Flexible Packaging

1. Introduction

Having investigated the evolution of barrier technologies in packaging, it became obvious that there is a requirement to build more functionality into many substrates used in food and other packaging that provides varying degrees of preservation. The packaging market's need for products that deliver enhanced shelf life, as well as sustainable, recyclable, metal-free and waste reducing solutions can be addressed through a new approach that competes with current barrier technologies.

2. Market need

Traditional structures of glass, tin and foil are often seen as formidable barriers but, like all barrier technologies, have their disadvantages. Weight is considered a limiting factor for these substrates. Plastics provide a poor barrier and, while coated plastics offer barrier improvements, there are downsides such as the generation of chlorine from PVdC, the presence of metal in metallized film, the thickness of extruded laminates, and the fragile nature of AlOx and SiOx coated films.
New emerging technologies, such as nano composites, can now be used to offset such deficiencies and these technologies can be formulated into Functional Coatings, suitable for printing on packaging.

The food packaging market needs are quite broad and include:

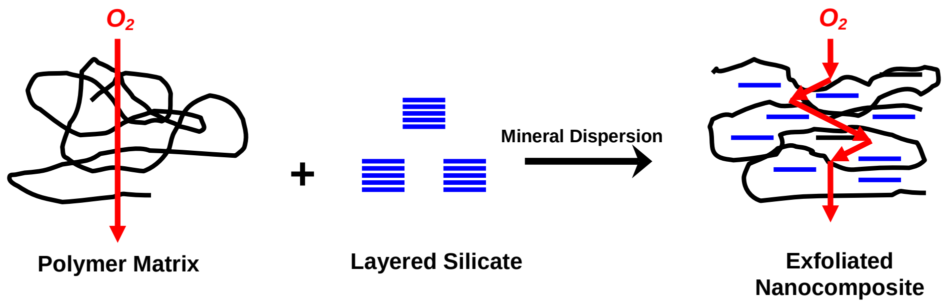
- Chlorine-free structures
- Alternatives to other more expensive barrier technologies
- Excellent O_2 /Gas/ aroma / odour barrier
- Barrier to other potential migratable compounds
- Extension of shelf life
- Light weighting
- Sustainability
- Reduced carbon footprint
- Replacement of structures, containing metallized film
- Recyclability
- Transparency
- Improved flex crack resistance when compared to oxide / metallized films
- Waste reduction

3. Product design

Barrier coatings that can be applied at conventional printing converting wet film weights are difficult to formulate. Significant improvement to gas barrier, as illustrated in Fig.1, can be obtained by dispersing or exfoliating mineral silicates in the organic polymers selected for Sun Chemical's coatings. In this category, clays provide the most significant improvements due to their "platy" structure. There are many types of clay which vary in crystal structure and "platiness".

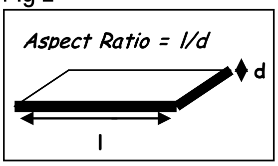
These minerals are very thin (about 1-3 nanometers) and, when correctly exfoliated in a coating, they align parallel to the substrate. Each platelet is an absolute barrier to oxygen so if they were to connect, side by side, would provide an excellent barrier. In reality, this has not been achieved in useful coatings technology , but when optimized so that the platelets align correctly and take up as much as 60% of the dry coating volume, a significant improvement in barrier performance is obtained. In effect, the diffusing gas has to find a pathway around the platelets which is described as 'tortuous' since the distance the gas must travel is several times the thickness of the coating. The transmission rate of the diffusing gas is therefore limited by the tortuous path it is forced to take.

Fig 1



Importantly, consideration must be given to the aspect ratio of a platelet, as shown in Fig 2. This is simply the ratio of the shortest to longest dimensions. A thickness of 1-3 nanometers is quite common in clay types, but it is those with one dimension approaching 1-10 microns (i.e. an aspect ratio of 1000-10000) that are most effective for use in barrier coatings. From an formulation standpoint, the chosen aspect ratio will be selected to achieve other desired barrier coating properties (eg lamianation bond strengths seen in Fig 3 . The graph below demonstrates how the aspect ratio and concentration of various particulates affect oxygen transmission.

Fig 2



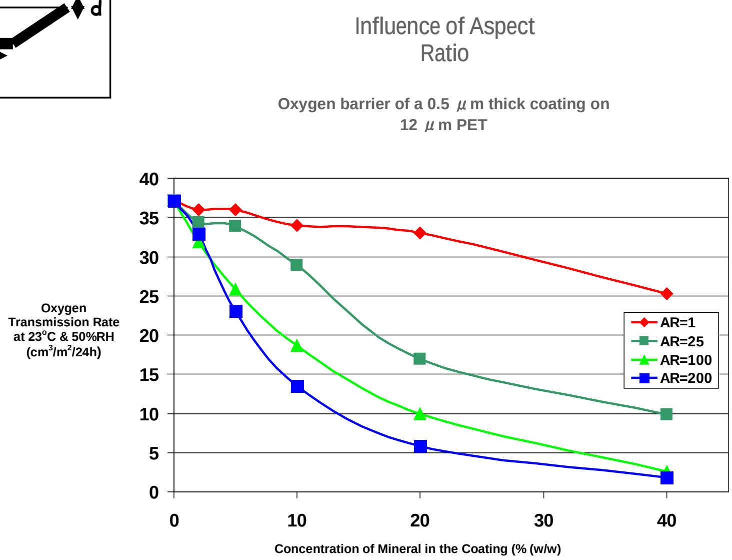
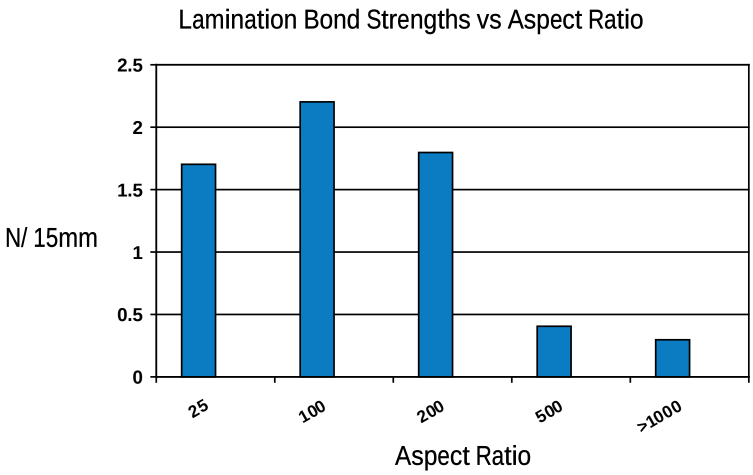


Fig 3



SunBar™ clay composite oxygen barrier coating technology is based upon an optimized ratio of ethylene vinyl alcohol copolymers and clays. The film forming polymer is very similar to EVOH extrusion polymers already used in barrier packaging. The clays have a platelet shape and enhance oxygen barrier performance. These platelets orientate in the coating, as it dries, to create a tortuous path for gas transmission, resulting in higher barrier properties, at much lower film weights, than are usual with extruded EVOH for example.

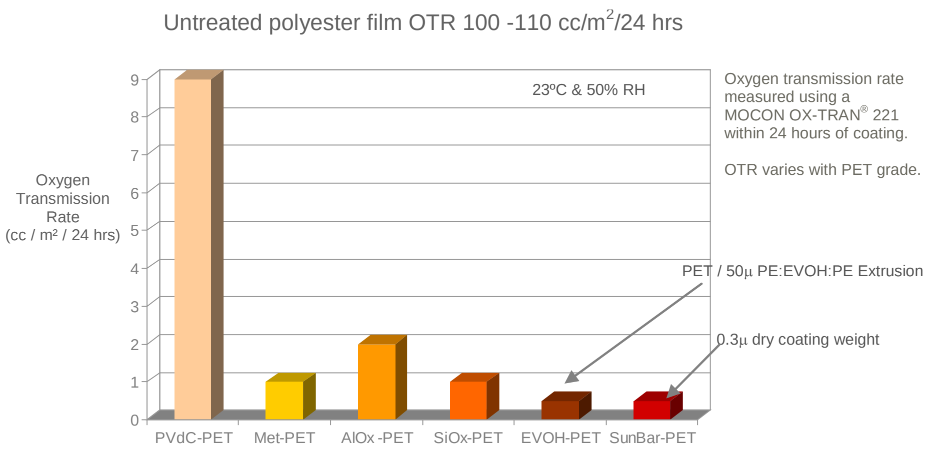
4. Product application

Clay composite coatings can be applied to various substrates, such as PET, polyolefins, polyamides, metallized and ceramic coated films, PLAs, as well as cellulosic and starch based products. (Depending on the substrate quality, a primer may be required) SunBar has similar moisture sensitivity to that of EVOH and has been designed for ‘sandwiching’ between two polymeric films in a laminate structure such that the composite effect provides good oxygen and moisture barrier. In certain circumstances, and depending on the packaging specifications, SunBar coatings could be applied to the surface of a substrate and then protected with a suitable, resistant overprint varnish. They have also been applied to paper and board and provide not only an oxygen barrier but also protection against the ingress and egress of odours and aromas.

At the point of use, clay composite coatings require very little preparation and application is very simple. It is a two component mix, resulting in a user friendly, press ready product. Although the product may contain some alcohol, depending on the application, it is easily washed up with water.

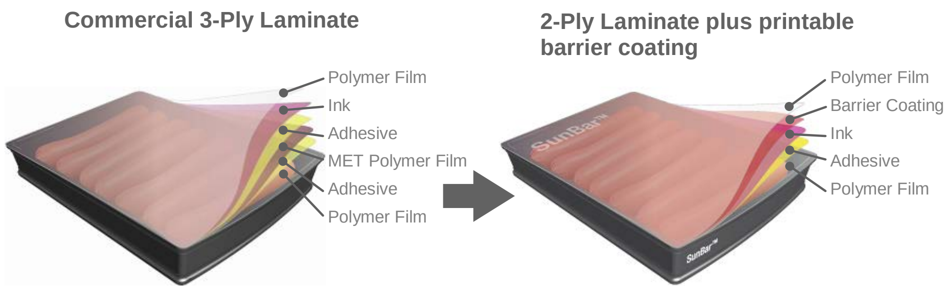
Boost corona discharge treatment is always required on non metallic surfaces to provide for uniform coating deposition and good lamination bonds.
Once applied and dry, the coatings form a smooth, homogenous, pinhole free layer that is easily overprinted with inks and can be laminated to a variety of secondary films using suitable adhesives. Bond strength is generally greater than 2N/15mm (330g/inch).
Applying SunBar to a film such as PET, at a conventional printing/coating wet film weight, provides superior barrier performance when compared to alternative filmic barrier technologies, as illustrated in Fig 4.

Fig 4



If we now evaluate a typical model barrier structure, as in Fig 5, it can be seen that significant benefits are derived from applying clay composite coatings to displace currently used technologies.

Fig 5

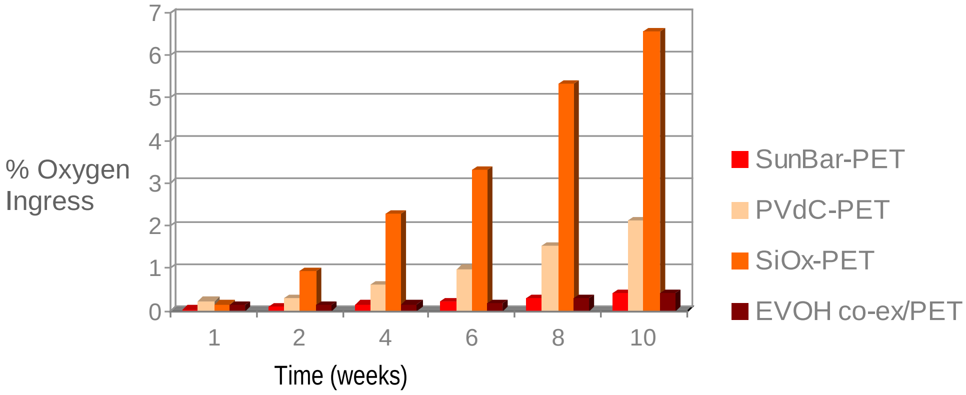


In this example, a layer of metallized barrier film, and one layer of adhesive, is being replaced by the coating, resulting in the packaging being light weighted. The flex crack resistance is improved and its enhanced oxygen barrier performance will result in an extension of its shelf life. There is also the potential for lower material and / or operating costs. Finally, if the primary and secondary substrates, within the laminate structure, are in the same polymeric family, the pack has greater potential to be recyclable.

Figure 6 represents a 10 week study of chilled food packages, prepared using clay composite coatings and other barrier technologies. As can be seen, the oxygen ingress of SunBar is comparable to EVOH and appreciably less than PVdC and SiOx.

Fig 6

Chilled Foods – Real Time Packaging Performance



5. Conclusion

Sun Chemical's oxygen barrier coatings are easily applied with few changes to current application equipment. These coatings can be applied to many filmic substrates to replace or enhance current barrier technologies in a sustainable, cost effective manner.
SunBar further meets all current non food contact regulations and is recyclable and biodegradable.

The benefits of using SunBar should be clear to packaging design specialist, brand owners and printer converters alike.

SunBar …

- provides an excellent barrier to MAP gases such as O_2 and CO_2, as well as aromas and odours
- is sensory approved for use in long shelf life dry food, chilled/refrigerated food* and liquid packaging
- provides robust lamination performance at high relative humidity*
- has excellent flexing properties
- can contribute to removing metal from laminate structures
- provides the opportunity to lightweight packaging
- contributes to both packaging sustainability and recycling demands

The application of SunBar in packaging structures does provide solutions to the market needs outlined.
The final package can be light weighted, sustainable and cost efficient. Considering the use of a printable, thin barrier coating can enable the next generation of packaging designs.

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Field Code Changed