# The fight for BOPP's youth

C2 asked Ronni Nielsen, project manager at the Danish Vetaphone A/S, to discuss the future of water based inks and adhesives on raw BOPP. Mr Nielsen, of course, has a reputation for getting to the bottom of such problems and providing expert technical solutions

Today, the use of water based inks and adhesives on raw BOPP are limited without the added use of an expensive primer. The reason for this is the materials' limited ability to react with oxygen, resulting in a maximum obtainable surface tension of 46dyn/cm, after using Corona treatment. The only solution today is to buy BOPP that is already primed or has an inline primer for the purpose.

The disadvantages of this are added cost, the fact that the primer is solvent based, and the fact that the total material thickness is greater. With the new EASI-Plasma technology, which Vetaphone just recently invented in cooperation with French Coating Plasma Industrie, it is said to be possible to obtain up to 60 dynes on BOPP, with by far the industry's lowest gas consumption. With such reduced running costs, Vetaphone promises its customers a return on investment of as little as 12 months.

## How corona works

To explain how this is possible, Ronni Nielsen takes a look at the chemistry of the BOPP surface. "Corona is an electrical discharge, typically ranging between 30 and 40kV. With this discharge, existing molecule chains are broken and new ones are created. The new molecule chains on the BOPP surface are mainly created from the oxygen in the 'air gap' from the uncontrolled atmosphere that surrounds us. The $O_2$ molecules break into O-atoms, which then connect with the CH-based groups on the surface of the plastic film, creating the molecule chains that are shown below.

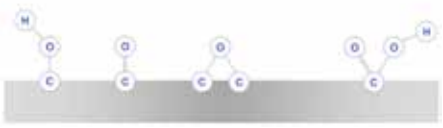

**Figure 1**

The bi-product of this is that the Oxygen atoms combine into Ozone ($O_3$), which is then removed from the area by the mandatory exhaust on the corona treater.

EASI-Plasma shares some similarity with Corona because the electrical discharge is achieved in the same way but, unlike Corona, which uses an uncontrolled atmosphere, EASI-Plasma works only with a highly controlled atmosphere, which for this application is Nitrogen based. By removing all the Oxygen, and replacing it with a controlled Nitrogen based atmosphere, EASI-Plasma is able to graft specific molecule chains on top of the surface. When aiming for high dyne levels on BOPP, the desired molecule chains created are predominantly Amine, Amide and Imide groups, as shown below in Figure 2. But in addition, by removing Oxygen from the air-gap, there is no longer any Ozone created.

Ronni Nielsen

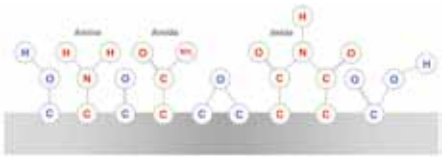

**Figure 2**

## EASI-Plasma

"But just creating the required molecule groups is not enough," underlines the Danish expert. "The knowledge of how to treat the surface evenly to the same dyne level, with the lowest possible amount of consumables, is the key to making the best and cheapest product. The secret lies in how to create the correct mix of molecule groups on each specific material in a highly controlled atmosphere."

The difference between Corona and the two types of EASI-Plasma treatment suited for high dyne levels on BOPP is illustrated below in Figure 3.

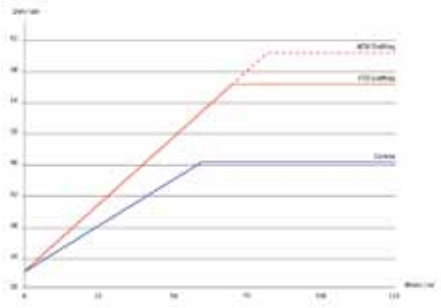

**Figure 3**

The chart shows the limitation of oxidisation of the surface. After reaching 46dyn/cm with Corona, merely increasing the power applied will not improve the surface tension further. However, with EASI-Plasma Standard Grafting, 56dyn/cm were obtainable on this specific BOPP material and, by using Advanced Grafting, the EASI-Plasma treatment was able to obtain a surface tension of 60dyn/cm. It's worth noting that, just as with Corona treatment, these two types of treatment do not benefit from increasing the power still further.

Looking at what EASI-Plasma does to the surface, it's no wonder that, in the past,

**The EASI-Plasma test facility**

people in the industry have concluded that it is a new and improved Corona treatment. But, to reach an accurate conclusion, one really needs to look at all the variables involved. At the end of the day, the price of material per $m^2$ is what matters. The consumer doesn't really care how the plastic film was produced. For many materials, it is still possible to obtain a significant surface adhesion from Corona so, for these materials, changing to EASI-Plasma would give little benefit.

## Stop the ageing

However, there is one great advantage of EASI-Plasma, and that is that it does not necessarily need to be done inline. The reason behind this can be found in the condition known as 'ageing'. After Corona treatment, the additives in the plastic film 'try to get back to the surface'. With the molecular structure that Corona has created on the surface, this is quite easy. Depending on the amount of additives, this ageing effect can be measured from hours to weeks. The fact is that it always decays until it reaches the 'native' level,

which for BOPP in this example was 32dyn/cm, as shown in Figure 3.

The effect of ageing of this BOPP material is shown in Figure 4.

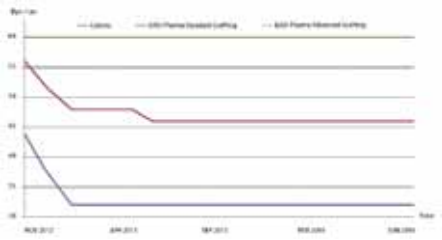

**Figure 4**

The chart shows that the Corona treated material starts to decay and, within two months has aged back to its 'native' 32dyn/cm. The EASI-Plasma Standard Grafting also decays at a similar pace, but the ageing stops at a higher level. Here, for example, it is 48dyn/cm, before decaying slightly to 46dyn/cm after six months, where it stabilises. However, with the EASI-Plasma Advanced Grafting, there is no ageing at all. The achieved 60dyn/cm on BOPP stays at this level even after a period of 18 months.

As is the case with Corona, when using different materials, one needs a different power per square area, also known as the Material Factor, which is measured in Watt/min/m², to reach the desired dyne level. Not only is this factor different for each material but even the same material from different suppliers can result in different material factor requirements, depending on the exact chemistry the producer is using to manufacture the product.

For EASI-Plasma it is not only the material factor that needs to be changed according to the material but also the atmosphere to create high and lasting dyne levels. By changing the gas-mix, which is all the Nitrogen based atmosphere really is, it is possible to tune the amount of the different molecule groups, as shown below in Figure 5.

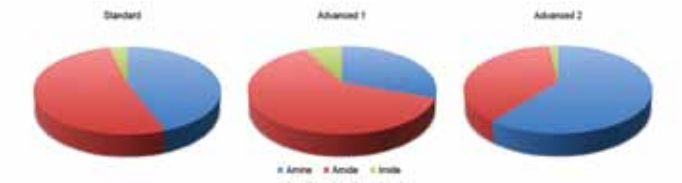

**Figure 5**

The exact gas-mix is easily created in the Vetaphone laboratory, and all the gases needed are available from any of the gas suppliers around the globe. The typical added running cost, compared with Corona, is between 0.30-0.50¢/m². The gas consumption of an EASI-Plasma system is less than half that of any other system on the market today. Not only does the system consume less gas but the gas is also royalty free, which means that it can be bought from any supplier the customer chooses.

"To date, the specific materials that Vetaphone has proven to obtain higher dyne levels with EASI-Plasma than Corona are PP, OPP, BOPP, PVC, PET, and PVDC," says Ronni Nielson. "The specific materials that we have proven to obtain longer lasting dyne levels with EASI-Plasma are BOPP, Fluorinated Polymers (FEP, ETFE and ECTFE), PE, PLA, COC, COP and textile. We are confident that this is just the beginning. As our chemists continue their R&D efforts, we're going to make recipes for many more materials available."