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Primer Intelligence
Extrusion-Coating with Polypropylene Resins

Many flexible plastics converters extrude low-density polyethylene ("LDPE") on a daily basis. This resin is easy to process and meets the customers' requirements for adhesion, cohesion, and chemical resistance. In some cases however, polyethylene is not the resin of choice. For example, if elevated temperature resistance or grease resistance are important, polypropylene might be a better choice. Although there are many polyethylene grades for extrusion-coating, there are relatively few polypropylene grades for extrusion coating & laminating. Fiber-grade and molding grade polypropylenes are commonplace, but do not process well in extrusion coating or laminating, because of their inappropriate molecular-weight distribution. However, a few resin suppliers have developed specialty polypropylene grades for extrusion coating. They are almost always blends with some low-density polyethylene to impart good draw-down properties.

At Mica Corporation, we have spent YEARS trying to improve the adhesion of extrusion-coated polypropylene to various substrates. We've learned it is not an easy task, but there are some things the converter can do to improve adhesion. These actions fall into three categories:

1. Process Conditions
2. Resin Selection
3. Selecting a Primer

Why is it so hard to get good adhesion with polypropylene? Understanding the answer to this question will help us understand how changes in these 3 categories can help. Using low-density polyethylene as the extrusion-coating benchmark, we can with reasonable confidence state some of the main differences affecting adhesion of polypropylenes:

- They are more crystalline (crystallinity varies greatly with different grades). Because of this, they are harder and therefore require more torque to extrude and more pressure to get good intimate contact with the substrate.

- They have higher melting points (as much as ~50°C higher (ca. 160 for polypropylene vs. 105-112 for low-density polyethylene). This results in much more rapid solidification during that few milliseconds in the nip, further reducing the chance for intimate substrate contact and molecular entanglement.

- ALL polypropylenes necessarily contain additives. Without them the polymer will degrade via chain-scission and rapidly lose physical properties. Partly because of the additives and partly because of the molecular structure, polypropylene does not undergo oxidation in the air-gap, therefore there are few functional groups for chemical bonding.

Now that we understand the differences between polypropylene and polyethylene, we can intelligently tackle those 3 categories: process conditions, resin selection, and primer selection.

Process Conditions

- Thickness, as with most adhesion cases, thicker is better. Why? Because a thicker melt curtain carries more heat into the nip and increases the chances of intimate contact and possible molecular entanglement with the substrate.

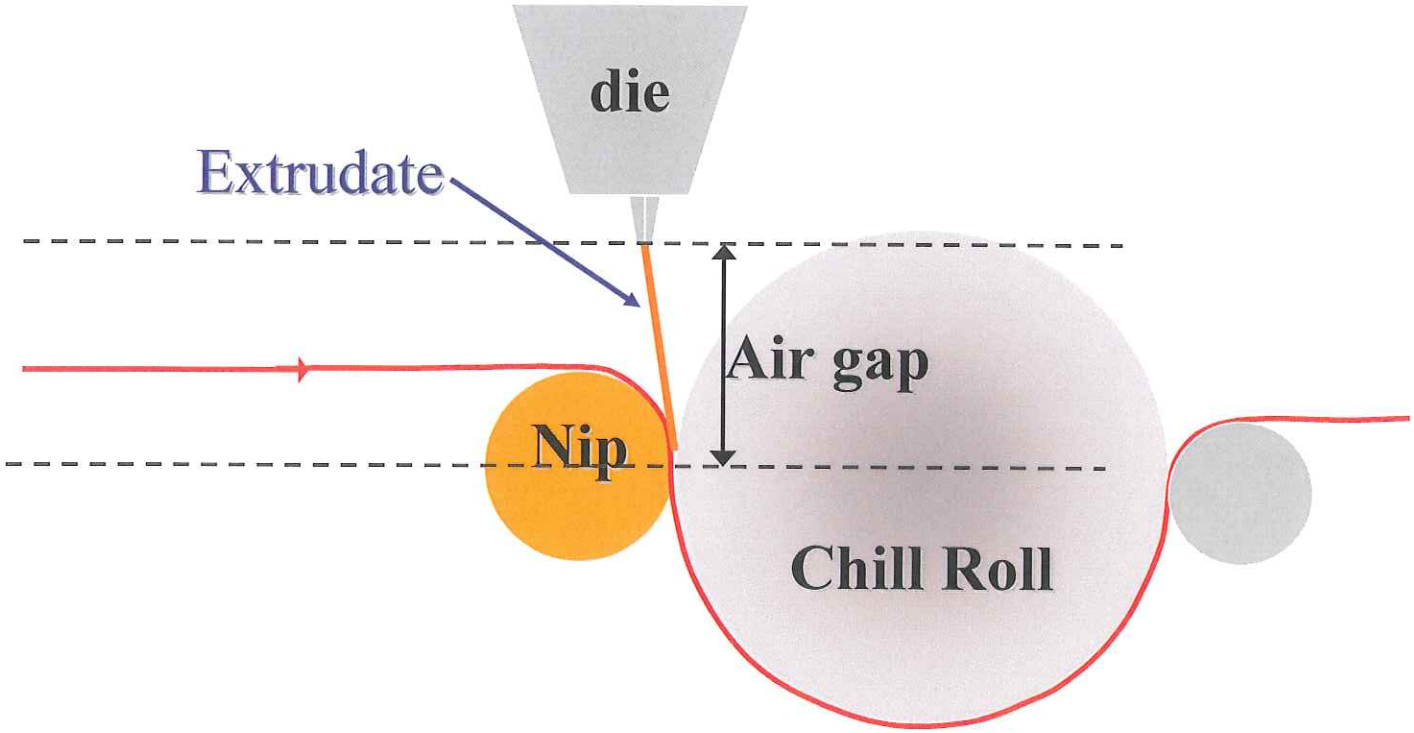
- Nip-roll pressure. Higher nip-roll pressure and a hard rubber roll will help get the polymer into the substrate before it solidifies.

- Chill roll temperature. HIGHER is better. Colder is worse. Also, a cold chill roll can cause shear fracture at high shear rates. In other words, the bonds are good when peeled slowly but bad when peeled fast or the bonds are good at room temperature but bad at low temperature.

- Air gap: SHORTER is better. Keeping the heat in the melt is better than cooling the melt in the air gap.

- Melt temperature: Hotter is usually better, but it *is* possible to run too hot and effect degradation that is not conducive to bonding.

The implication is clear. To get good adhesion, one must do everything possible to lower the crystallinity of the polypropylene at the melt/primer/substrate interface. Polypropylene crystallizes much faster than polyethylene because it is more crystalline and because the melt point is much closer to the extrusion temperature so it "freezes" much quicker. The cold substrate itself will cause the interface to"freeze".



Resin Selection

Lower crystallinity grades and slower crystallizing grades tend to bond better than higher crystallinity fast crystallizing ones. Usually, copolymers bond better than homopolymers, but with all grades, the additive package can play a significant role. You should discuss your application with the resin supplier and use their technical expertise to select a grade specifically formulated for extrusion-coating. It's also possible to improve the bonding

of polypropylenes by adding maleated polypropylenes at the hopper. Several resin producers make maleic-modifed polypropylenes. Your Mica Technical Sales representative can help you find them.

Primer Selection

Mica Corporation makes several primers that can impart adhesion to extrusion-coated polypropylenes. The choice of primer depends on the substrate, the extrudate, and the end-use requirements. Again, contact your Mica Technical Sales representative to make the best choice for your application.

By observing as many of the above suggestions as possible, you just might find a polypropylene solution that is good for your converted products portfolio.