

There are a number of different types of elastomers that can be utilized as impact modifiers in various polymers. The specific type of elastomer, and the loading level needed, will be dependent on a number of variables such as cost, efficiency, desired level of impact, flow, and balance of overall properties. Regardless of the type of impact modifier or the polymer type it is being utilized in, there is one common factor: the reduction in the melt flow of the final compound. This is especially true with impact modifiers that are chemically reactive (i.e. containing maleic anhydride).

The final viscosity of a compound in which an impact modifier is added will be dependent on the viscosity and percentage of both the base polymer and the impact modifier. Because viscosity is a complex function, one cannot simply use the rule-of-mixtures to calculate the final viscosity of the compound. For example, according to the rule-of-mixtures, if you make a blend with 80% of a 10 MI HDPE and 20% of a 2 MI POE impact modifier you would get a final MI of 8.4 g/10 minutes. However, this would be incorrect. Using the formula $n_B = (n_1 W_1) + (n_2 W_2)$, where n_B is the MI of the blend, n_1 and n_2 are the MI of the blend ingredients and W_1 and W_2 are the weight percentages of the ingredients, would give a more accurate estimate of the MI as 7.25 g/10 minutes.

Of course, using a higher MI impact modifier would result in less loss of MI in the final compound. Again assuming a 10 MI HDPE at 80% but using a 30 MI POE impact modifier at 20%, the final MI would be 12.4 g/10 minutes. However, using a higher MI impact modifier can result in lower impact performance, especially at cold temperatures.

When impact modifying polypropylene with a POE impact modifier, keeping the viscosity ratio as close as possible will result in higher impact performance. The viscosity ratio is the ratio of the viscosity of the POE modifier to that of the PP base polymer measured at 190°C and 100 rad/sec. The closer this ratio is to 1, the better the dispersion of the impact modifier. Better dispersion results in overall better impact performance in the final compound. This viscosity ratio becomes more critical in high flow compounds. In PP / POE compounds where the viscosity ratio is high, it is possible to add a compatibilizer to better 'tie-together' the higher MI PP and lower MI POE components. This allows one to make a compound utilizing a lower MI POE impact modifier for higher performance while still utilizing a high MI PP for better flow properties in the final compound.

For the impact modification of nylon, one would commonly use a maleic anhydride modified impact modifier such as POE-g-MA or EPDM-g-MA. Because of the chemical reactivity of the maleic anhydride, the melt flow index of the final nylon compound is significantly reduced from that of the initial nylon polymer. For example, a 20% loading of EPDM-g-MA in nylon 6 can reduce the melt flow index by almost a factor of 10.

There are a variety of different impact modifiers that can be used to impact modify various polymer systems but each one comes with various tradeoffs, primarily in regards to impact performance versus flow properties. However, having an understanding of the different properties and characteristics of the impact modifiers and their effect on the final compound properties allows one to effectively formulate a compound with the maximum balance of properties.

VISCOSITY / FLOW

Easy Flow /
Low Viscosity



Moderate
Flow /
Moderate
Viscosity



Poor Flow /
High Viscosity

