

Migration of Erucamide in Polyethylene Films at Elevated Temperatures

Johnpeter Ngunjiri, Pacholski Michaelleen and Sharma Rahul

DOW, United States

Slip agents are added to polyethylene (PE) films because of their ability to modulate film surface properties such as coefficient of friction (COF) that are critical in film processing. Certain storage conditions such as elevated temperature impact the levels of slip agent present at the film surface during subsequent processing. The migration of erucamide in heat aged polyolefin films will be discussed as studied using Atomic force microscopy (AFM), X-ray photoelectron spectroscopy (XPS), secondary ion mass spectroscopy (SIMS) and infrared spectroscopy (IR). Examples showing surface chemistry and morphology of PE films containing erucamide that were heat aged at different temperatures will be discussed.

Room temperature film-to-metal COF of low density and linear low density PE films is typically greater than 0.4. For high speed roll-to-roll processing of these films it is desirable to have COF less than 0.2. In order to bring the COF of PE films in the desired range, small amounts of migratory slip agents like erucamide are added at the time of film fabrication. Due to poor solubility in PE at room temperature erucamide phase separates as the films cool after exiting from the die, and over time (on the order of a few days) migrates to the surface.¹ It crystallizes at the surface and the crystals stack up in discrete layers.² It is believed that slippage of crystal layers with respect to each other provides a lubrication effect, which is responsible for achieving low COF.

The COF of as-manufactured PE films can be reduced to as low as 0.1 by the addition of only 500 – 2000 ppm of erucamide.³ However, COF increases as the films get exposed to elevated temperature during transportation and storage. Hirt and coworkers had investigated the effect of temperature on bulk-to-surface partitioning of erucamide in PE films and its chemical stability.⁴ They had concluded that (i) a significant amount of erucamide migrated back into the film at this temperature, and (ii) a small amount of erucamide present at the surface decomposed due to oxidation. It had previously been shown that COF increases with reduction in surface concentration of erucamide, particularly if the surface concentration decreases below a certain threshold.⁵

References

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