

ON THE STABILITY OF RECYCLED POLYOLEFINES

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The amount of mixed plastic waste from packaging materials containing about 90% of polyolefines rapidly grows. The ecological situation requires a search for more effective recycling methods. Sorting of the post-consumer packaging with various dimensions into pure plastics-type fractions is the main problem.

It is nearly impossible to separate different polyolefines from one another in melt. The recovered blends or alloys usually have insufficient service properties, because polyolefines have limited mixing with one another. Instead of the recovery in the molten stage, technologies of selective dissolution of different polyolefine fractions were developed. By these methods, practically pure polymer fractions can be extracted from mixed plastics waste at definite temperatures. Practically no serious studies on the macromolecular chain degradation and oxidative stability after recovery in solution carried out.

The aim of the present work was a complex study of the stability and degradation of recycled polyolefines after various recovery technologies. The recycling process in melt was simulated as repeated extrusions on a one-screw extruder at 20 rpm. The temperature settings were 200°C for LDPE, 230°C for HDPE and 235°C for PP. After each extrusion cycle, a part of material was taken for measurements and the rest extruded once more without restabilization. The selective dissolution was carried out in xylene at 125°C and in a definite mixture of aliphatic alkanes at 140°C. The materials were dissolved and kept by stirring in the solvent for 1, 2, 3, 5, 10, and 24 hours. For these investigations, three commercial-grade polyolefines: PP from Solvay (Eltex P HL 402), HDPE from Vestolen GmbH (Vestolen A 6042) and LDPE from BASF (Lupolen 1800 H) were used. Oxidation of polymers was controlled by the carbonyl index (CI) determination using IR-spectroscopy, crystallinity — by DSC, and stability — by chemiluminescence.

For recycled polyolefines, the stress and elongation at break decrease by 10% and 25%, correspondingly. For recycled PP and HDPE, the crystallinity increases, which allows us to assume that the molecular mass decreases as a result of chain scission. For LDPE, the crystallinity decreases, which can also result from an increase in the molecular weight, short-chain branching (scission of long-chain branching) or crosslinking. For PP and HDPE, an increase in MFI with extrusion cycles confirms the results of DSC measurements of chain scission. For LDPE, the decrease in MFI values allows us to conclude that crosslinking prevails.

The IR-spectroscopy results showed that the growth in CI depends on the recovery method. For each polymer, the lowest CI was obtained after repeated extrusions, the highest CI - after dissolution in alkane mixture. The chemiluminescence results showed that the stability decrease with recycling. These trends are the same as for the oxidation degree.

After cooling and filtration of the solution, the soluble rests (~2 wt.% in xylene and ~6 wt.% in alkane mixture) were found in the solvents. Their analysis showed

that the additives and stabilizers are washed out during the dissolution. As the result, thermooxidative stability of the polymer decreases. If the recycled material is restabilized, its stability is equal to that of the primary polymer.

Stability of recycled polyolefine depends on the recovery methods used. The recycling by selective dissolution requests restabilization, because the additives are extracted by the solvent. Degradation of the service properties is not essential for the further use of the materials.