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COMPOSTABLE FILMS OF MATER-BI Z GRADES

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ABSTRACT

This paper focuses on the composting behavior of Mater-Bi Z grades for filming and on their in-use behavior, mainly as composting bags for the collection of organic waste. The compostability of Mater-Bi Z grades was demonstrated by means of a three-step test by following the approach of different international committees working on this matter comprising lab tests (biodegradability tests such as ASTM D 5338, ASTM 5901, and terrestrial toxicity tests) and full-scale composting tests. In addition to their compostability, the in-use behavior was estimated by tests of separate collection of organic wastes in different municipalities (Furstenfeldbruck/Bavaria, Korneuburg/Austria) comparing paper bags with Mater-Bi bags.

INTRODUCTION

Novamont produces three classes of biodegradable materials, A, Z, and V, under the Mater-Bi trade mark. They all contain thermoplastic starch, characterized by different synthetic components:

A class products: biodegradable, not compostable because the degradation time is inconsistent with a composting cycle. They are mostly used for rigid-injected or blow-molded parts.

Z class products: biodegradable and compostable. They contain aliphatic polyesters and are particularly suitable for the production of films, layers, and injected or blow-molded parts.

V class products: biodegradable, compostable, and soluble. They are mostly used as a substitute for expanded polystyrene.

In all cases the transformation technologies for traditional plastics can be applied with minor modifications.

This paper focuses on the compostability of Mater-Bi Z grades for filming and on their in-use behavior, mainly as composting bags for the collection of organic wastes.

EXPERIMENTAL

All the data of this paper relate to Mater-Bi grades of the Z class: ZF02U, ZF03U, and ZI01U. They contain around 50% polycaprolactone plus starch and other natural plasticizers and compatibilizers.

Pure cellulose and different types of paper have been used as reference materials.

The compostability of these materials was demonstrated by means of a three-step test according to the approach followed by different international committees (ISR/ASTM, CEN, ORCA) working on this matter.

1. Intrinsic biodegradability of the material by standard respirometric tests simulating composting conditions (ASTM D5338) and watery environments such as the urban depurator (OECD modification of Sturm Test) [1–4].
2. Terrestrial Toxicity Tests (see germination [5], terrestrial plant growth [6], and worm acute toxicity [7]) and physical-chemical characterization of the compost obtained by Point 1, and prepared according to an ASTM procedure "for preparing residual solids. . . . "
3. Final cross-verification through full-scale composting trials. Full-scale composting plants covering different technologies (static windrows, turned windrows, rotary fermenting reactors) and different locations (Germany, Italy, Japan) have been considered.

Tensile and tear properties of these products are in line with those of LDPE, and the water permeability is one order of magnitude higher than that of LDPE.

Experimental projects of separate collections of organic wastes were performed in different municipalities (Furstenfeldbruck/Bavaria [8]; Korneuburg/Austria [9]; Padova, Brescia, Trento, etc./Italy) comparing paper bags with Mater-Bi bags to estimate, in addition to their compostability, their in-use behavior.

RESULTS

Compostability Test

Intrinsic Biodegradability

Modified Sturm Test. The test procedure is close to ASTM D5209-91 and to the test of the Italian decree DM 7/12/90. The test forecasts, in parallel, the analysis of well known reference substances (sodium acetate, Lissone paper for food contact) [1, 2]. All Z grades show a biodegradation index ($CO_2/ThCO_2$) at 56 days quite similar to that of the paper for food contact, according to what is required by the Italian ministerial decree DM 7/12/90 to define an unsoluble material as biodegradable.

Controlled Composting Test (ASTM D5338). The test simulates a composting environment and compares the biodegradation behavior of the test material with that of pure cellulose, both at concentrations of 10% w/w. In 45 days of testing the biodegradation indexes for ZF02U, ZF03U, and ZI01U were 74, 78, and 100%, respectively, against values around 85% obtained for pure cellulose [10, 11].

Terrestrial Toxicity Tests

The tests of seed germination, terrestrial plant growth, and worm acute toxicity, together with the physical-chemical characterization, performed by OWS [12] on the compost obtained by ASTM test D5338, gave results comparable with both the reference composts from the degradation of cellulose and for the control compost.

Full-Scale Composting Tests

The tests performed on different plants in Europe and Japan showed a complete disappearance of the material and an excellent compost quality. The main composting plants which tested Mater-Bi Z products were Scuola Agraria-Parco di Monza/Italy (static windrows) [13], Scuola Agraria-San Michele all'Adige/Italy (turned windrows), and Nogi-Cho Recycling Center/Japan (rotary fermenting reactor) [14].

As an example, Scuola Agraria of Parco di Monza composted pen caps of ZI01U in a static windrow, threaded with a plastic line, and entangled in a plastic tubular net. At the end of the cycle, the nets were empty and only residual lumps, stuck on the net with the typical appearance of compost, were recoverable. Other solid natural products in the heap, such as small pieces of wood, were yet not degraded, with only the surface being slightly attacked.

In-Use Behavior of ZF03U Composting Bags

The in-use behavior of 6-L ZF03U bags was evaluated by tests of separate collections of the organic wastes organized by different municipalities.

As an example, in Furstenfeldbruck Municipality/Bavaria, 55.7% of the citizens involved in the experiment were in favor of Mater-Bi bags whereas 28.6% were in favor of paper bags. In Korneuburg Municipality/Bavaria, 87% of the citizens preferred Mater-Bi bags. The compost quality was found to be in line with the national specifications for compost.

CONCLUSIONS

The results of full-scale composting tests and of standard lab tests performed by OWS on the biodegradation behavior of Mater-Bi Z grades and on the terrestrial toxicity of the resulting compost prove the compostability of these materials. Moreover from a functionality point of view, the experiments with separate collections organized in different European countries together with the physical-chemical characteristics of the film demonstrate the good in-use performances of Mater-Bi bags.

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