Rapidly-Biodegradable Hydrophobic Material

RADEMATE Ltd.

A New Approach to Biodegradable Products

Rademate, Ltd has developed a rapidly biodegradable hydrophobic material (RBHM) as a coating for cellulose-based materials. RBHM is a new, hydrophobic, strong, inexpensive, and completely biodegradable material that is environmentally friendly. RBHM greatly improves the properties of both paper and plastics packaging materials. Due to its biodegradable nature, RBHM is ideal for disposable loose fill bags and packages. The material can be used as a commodity in trade, industry and agriculture for a wide range of applications.

To date, most attempts to produce biodegradable products for consumers focused on developing plastics that could biodegrade. RBHM approaches biodegradable products from the other direction — making a material with the same physical properties as plastic, except the material biodegrades completely in the same time as regular paper bags.

Applications

The number of potential applications for RBHM is immense. Because RBHM can be applied on sheets, films and fibers, it is suitable for a range of single-use products, including, grocery and waste bags, the top and back sheets of disposable diapers, packs and disposable eating utensils. It can be used to create agricultural films and bags that cover ripening fruit.

RBHM products such as disposable plates and cups, films for food packaging, miscellaneous everyday items and sanitary products are but a few of the possible applications. Box and bag consumers are generally commercial and industrial users requiring a partic ular packaging container for a specific product.

Everyday Items

Trash bags, grocery bags, cups, plates, tablecloths and other household goods

Packaging Materials

Carton boxes, disposable containers for food processing, bags for industrial products, others;

Agricultural Uses

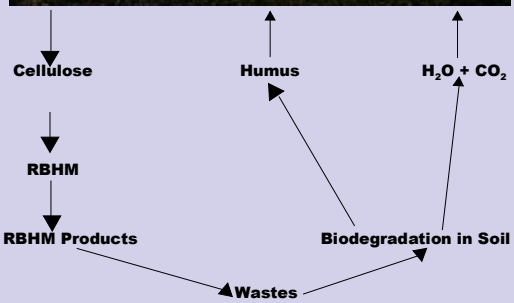
Mulch material, pots, composting bags for agriculture wastes;

Textile and Other Industry

Biodegradable textile materials, synthetic leather, biodegradable membranes [2]

Sanitary Products

Protection layer for disposable hygienic materials - diapers, sanitary napkins, panties, towels, etc.



Biodegradation Process of RBHM

RBHM uses cellulose (paper) with a biodegradable organic coating . RBHM is totally waterproof and biodegradation only occurs in wet soil under normal enzymatic action of various microorganisms, fungi and bacteria, as follows:

In aerobic conditions (top soil layers)

$C_nH_mO_k$ (RBHM) + O_2 + enzymes $\rightarrow$ CO_2 + H_2O + Biomass (Humus)

In anaerobic conditions (lower soil levels)

$C_nH_mO_k$ (RBHM) + enzymes $\rightarrow$ CH_4 + Biomass (Humus)

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Advantages

High Strength

RBHM measured in dry conditions and determined according ASTM D 828 and in wet conditions by ASTM D 829 (see the table in Section 2). Such strength characteristics, especially combined with low elongation and acquired water resistance of the material, make RBHM unique and highly desirable for packaging applications.

Water Resistance

RBHM keeps water resistance. Thus it has excellent prospects for many packaging applications. Most of the existing biodegradable packaging products are not hydrophobic at all and will fail if wetted during use.

Grease and Oil Resistance

RBHM is stable against greases, oils and nonpolar organix solvents: Kit Number is >12.

Recylclable

RBHM can be recycled as well as its base material, cellulose, paper, cartons, etc.

Full Degradation in the Environment

Enzymes begin breaking down RBHM in the presence of moisture in natural environments such as soil. Then microorganisms decompose the material with rapidly-occurring metabolic reactions. RBHM is completely converted into carbon dioxide, water and biomass in 2 - 3 months in wet soil. Thus this process completely coincides with the definition of biodegradability given by most experts. [1]

RBHM Uses Reproducible Natural Raw Materials

The cheapest raw material, as well as the most widespread organic material in nature, is cellulose. Cellulose is renewable, reproducing itself through the natural cycle. Sound environmental management balances resources, recycles and uses renewable resources whenever possible. Cellulose is present widely on the planet — in trees, bushes, grass and other plants.

Relatively Low Cost

The main obstacle to widespread use of biodegradable polymers is cost. Biodegradable polymers are significantly more expensive ($USA 10 - 1000) than commodity polymers ($USA 2 - 5). The high costs involved in the production of biodegradable polymers means that they cannot compete favorably with conventional polymers. RBHM has no such cost barriers, characteristic of all the other biodegradable plastics. This high cost blocked the widespread adoption of biodegradable plastics in major consumer application. As RBHM is a cellulose-based material, it can be manufactured with the existing paper and pulp industry equipment using existing technologies. This means that it is only insignificantly more expensive to produce than to produce paper itself. Currently available degradable materials on the other hand can cost twice as much.

Specifications

RBHM is a new, specifically developed material, based on cellulose. The superior properties of RBHM are due to the following: [3]

- development of a specially biodegradable hydrophobic composition;
- development of a cellulose substrate with optimal combination of long and short fibers and water-resistant inner fiber contacts; and
- hydrophobization of the cellulose substrate by special composition.

RBHM is a hydrophobic strong, cheap and fully biodegradable material. Product properties are diverse and customizable, but generally mimic both polyethylene and paper products. The following table contains a summary of properties of experimental samples of RBHM and a comparison of the results to other packaging materials.

Decomposition of RBHM is slightly longer than the basic cellulose material but not more than a few weeks, making the material an ideal coating to strengthen without causing a long time for decomposition. (See the following illustration).

	LDPE	Bioceta	Materi-Bi-(Z)	RBHM
Tensile strength, kg/mm^2 - dry conditions	2-3	3-4	2-3	4.5-6
Tensile strength, kg/mm^2 - wet conditions	1.9-3	2.3-3.2	1.4-2.3	3.4-5.5
Water vapors transmission, g/(h m^2)	1-3	5-6	10-30	3-4
O_2 Permeability Px10^{13} (cm^{3}cm)/(cm^{2}secPa)	1-2	0.5-0.7	0.5-0.8	0.2-0.4
Rate of biodegradation, % in wet soil, 6 mo.	0-0.5	20-30	100	100
Time of biodegradation in wet soil	> 10 years	1 year	1-2 mo.	1-2 mo.
Cost in USA per kg	$2-2.5	$8-10	$5-6	

References

1. Proceedings of the “Biodegradable Plastics - 99” Conference. Frankfurt-Main, Germany, Apr. 1999.
2. Ioelovich M. Study of the Gel-Filter Parameters for Fine Purification of Water. Ecological Problems of Israel - Abstracts of the first annual Meeting, Aug.1998.
3. Ioelovich M. Progress in Technology of Biodegradable Polymer Materials. Conference: “Innovation and Enterprise for Progress in the Plastic and Rubber Industry of Israel”, Dec. 1998.