

BIODEGRADABLE COMPOSITE AND PRODUCT CONTAINING BIODEGRADABLE COMPOSITE

BACKGROUND OF THE INVENTION

Technical Field

[0001] The present invention relates generally to a biodegradable composite, and more particularly to a biodegradable composite that is compostable and a product containing the biodegradable composite.

Description of Related Art

[0002] Nowadays, when life becomes more convenient, plastic garbage and waste are increased day by day. Even though some recycling companies do recycle plastic garbage and waste, plastic garbage and waste are too much to be recycled and to be decomposed. Therefore, plastic waste pollutes and damages the environment.

[0003] Recently, since plastic pollution is too serious, related companies try to develop biodegradable plastics which could be decomposed naturally to reduce the environmental burden. However, under a natural situation, biodegradable plastics need more than 300 days to be decayed completely. Therefore, within a short period of time, an efficacy of reducing the plastic waste by using the biodegradable plastics instead of normal plastics is not significant.

[0004] On the other side, generally, biowaste, including food waste, kitchen waste, animal and plant residues, and so on, could be composed to allow the biowaste to return to the natural environment. However, in fact, when the biowaste does not be properly processed (decomposed or fermented), an unpleasant odor, plant diseases, and pest outbreaks may occur. For example, when the biowaste is decayed under an anaerobic situation, organic acid, alcohol, ketone, sulfide (e.g. hydrogen sulfide, H_2S), nitride (e.g. skatole C_9H_9N and ammonia NH_3), and other odor gases are possibly generated.

[0005] Except the odor gases generated during the decay of the biowaste, some other odor substances are existing in a normal environment, such as xylene and toluene that are

generated during evaporation of an adhesive solvent, marsh gas that spreads from a sewer, cooking odor, rancid odor, and so on. Besides, during industrial manufacture, odor gases may be generated as well. For example, thiol, hydrogen sulfide, and/or amine gases may be generated during desulfurhydrogenation of petroleum, hydrodenitrification of petroleum, and degradation of resin.

[0006] Therefore, a biodegradable composite and a product containing the biodegradable composite, which could speed up the degradation of the biodegradable plastic to avoid unpleasant smells, are needed. Furthermore, the biodegradable composite and the product facilitate a decomposition process of the biowastes to form composts, so that the biowaste could be recycled, thereby achieving an ecofriendly and sustainable development goal.

BRIEF SUMMARY OF THE INVENTION

[0007] In view of the above, the primary objective of the present invention is to provide a biodegradable composite and a product containing the biodegradable composite, which could efficiently degrade the biodegradable plastic, effectively suppress bad odors, and facilitate the biowastes to be decomposed to form a biobased compost, thereby achieving environmental protection and circular economy.

[0008] The inventive subject matter provides a biodegradable composite, which could instantly deodorize and accelerates a decomposition process to form compost, including an organic matter and a porous material. The organic matter accounts for 40% to 80% of a weight of the biodegradable composite, wherein the organic matter includes viable bacteria and has a total plate count that is greater than or equal to 10^4 CFU/g. The porous material accounts for 20% to 60 % of the weight of the biodegradable composite.

[0009] The inventive subject matter further provides a product, which could instantly deodorize and accelerates a decomposition process to form compost and is adapted to contact a biological substrate. The product includes a biodegradable composite and a

biodegradable plastic. The biodegradable composite includes an organic matter having viable bacteria and a porous material, wherein the organic matter accounts for 40% to 80% of a weight of the biodegradable composite, and a total plate count of the organic matter is greater than or equal to 10^4 CFU/g. The porous material accounts for 20% to 60 % of the weight of the biodegradable composite. The biodegradable composite accounts for less than or equal to 10% of a weight of the product. The biodegradable plastic is decomposable by biological activities and contacts with the biodegradable composite

[0010] With such design, by utilizing the biodegradable composite and the product containing the biodegradable composite provided by the present invention, the speed of degradation of the biodegradable plastic could be enhanced. Additionally, the porous material of the biodegradable composite and the product has great absorption capability for absorbing the unpleasant odors, such as xylene and toluene of the solvent of the paint and the adhesive or other bad odors generated during the industrial manufacture. Therefore, the biodegradable composite and the product could prevent the effusion of the unpleasant odors and accelerate the degradation of the biowastes to form the biobased compost, thereby enhancing environmental protection and recycle.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0011] The present invention will be best understood by referring to the following detailed description of some illustrative embodiments in conjunction with the accompanying drawing, in which

[0012] FIG. 1 is a line graph, showing absorption of Volatile Organic Compounds (VOC) by each of the different composites of the comparative examples.

DETAILED DESCRIPTION OF THE INVENTION

[0013] A biodegradable composite of an embodiment of the present invention, which could instantly deodorize, be fast decomposed to form compost, includes an organic matter and a porous material. The organic matter accounts for 40% to 80 % of a weight of

the biodegradable composite, wherein the organic matter includes viable bacteria and has a total plate count that is greater than or equal to 10^4 CFU/g; the porous material accounts for 20% to 60 % of the weight of the biodegradable composite. In the current embodiment, the total plate count of the organic matter is 5×10^7 CFU/g to 5×10^8 CFU/g, which meets a standard of a total plate count of a microbial fertilizer. In the current embodiment, the organic matter accounts for 40% to 45 % of the weight of the biodegradable composite, and the porous material accounts for 55% to 60 % of the weight of the biodegradable composite. In another embodiment, the organic matter accounts for 60% to 70 % of the weight of the biodegradable composite, and the porous material accounts for 30% to 40 % of the weight of the biodegradable composite. In the current embodiment, a sum of a weight of the organic matter and a weight of the porous material is equal to the weight of the biodegradable composite.

[0014] In the current embodiment, the viable bacteria are selected from a group consisting of thermophilic bacteria, *Bacillus coagulans*, *Bacillus subtilis*, *Bacillus thuringiensis*, *Pseudomonas putida*, Actinobacteria, and a combination thereof.

[0015] In the current embodiment, the porous material is selected from a group consisting of activated carbon, eggshell powder, shell powder, bamboo charcoal powder, and a combination thereof. The porous material has porosity and is good at absorbing unpleasant odors emitted by paint solvent, adhesive solvent (e.g. xylene and toluene), or emitted during an industrial manufacture, so that the unpleasant odors could be prevented from spreading or escaping, thereby providing efficacy of deodorization. In the current embodiment, a weight ratio of the organic matter to the porous material is ranged from 0.6:1 to 1.2:1. In the current embodiment, each of pores of the porous material averagely contains 800 CFU to 1200 CFU of the viable bacteria per gram of the biodegradable composite. In the current embodiment, the biodegradable composite includes water that accounts for 1% to 3% of the weight of the biodegradable composite. In the current embodiment, a sum of

the weight of the organic matter, the weight of the porous material, and a weight of the water is equal to the weight of the biodegradable composite.

[0016] An experiment mentioned below is designed for testing and illustrating how the volatile organic compounds (VOC) is affected by each of composites of multiple comparative examples, the result of the experiment is illustrated in FIG. 1. In this experiment, the VOC is toluene.

[0017] Composite of comparative example A is the organic matter having the viable bacteria, and the organic matter is 3 kg. Composite of comparative example B is activated carbon of 3 kg. Composite of comparative example C is a mixture that combines the organic matter containing the viable bacteria of 1.5 kg and activated carbon of 1.5 kg. Composite of comparative example D is the mixture of 3 kg mixed with water of 50g, wherein the mixture combines the organic matter containing the viable bacteria of 1.5 kg and activated carbon 1.5 kg.

[0018] Put each of the composites of the comparative examples A to D in an environment with toluene, wherein an initial concentration of the toluene is 8000 ppm), and then observe and assess a toluene absorption capacity of each of the composites of the comparative examples A to D at different times, thereby comparing a deodorizing capacity of each of the composites of the comparative examples A to D.

[0019] Table 1

Concentration of toluene (ppm)	Time to measure the toluene (VOC)			
	T=0 hr	T=1 hr	T>1 hr	T>16 hr
Comparative example A	8000 ppm	3040 ppm	3385 ppm	3693 ppm
Comparative example B	8000 ppm	226 ppm	998 ppm	3385 ppm
Comparative example C	8000 ppm	159 ppm	1232 ppm	2870 ppm
Comparative example D	8000 ppm	169 ppm	938 ppm	2689 ppm

[0020] As illustrated in table 1 and FIG. 1, as to the comparative example A, wherein the composite is the organic matter containing the viable bacteria. At the first hour after the composite of the comparative example A is put into the environment with toluene ($T=1$ hr), the concentration of toluene is 3040 ppm. Comparing with the comparative examples B to D, the toluene absorption capacity of the composite of the comparative example A is the worst among all the comparative examples.

[0021] Referring to the comparative examples B and C, the composite of the comparative example B is merely activated carbon. Comparing with the comparative example B, the composite of the comparative example C has the same weight and further includes the organic matter containing the viable bacteria. When the measuring times are between the first hour and the sixteenth hour ($T>1$ hr), the concentration of toluene of the comparative example C averagely is 1232 ppm, and the concentration of toluene of the comparative example B averagely is 998 ppm. The average concentration of toluene of the comparative example C is greater than that of the comparative example B. However, when the measuring times are between the sixteenth hour and the twenty-fourth hour ($T>16$ hr), the concentration of toluene of the comparative example C averagely is 2870 ppm and the concentration of toluene of the comparative example B averagely is 3385 ppm. The average concentration of toluene of the comparative example C is obviously smaller than that of the comparative example B. As a result, when the comparative example B and comparative example C have the same weight, the toluene absorption capacity of the composite the comparative example C is better than that of the comparative example B.

[0022] Furthermore, comparing with the comparative example C, the comparative example D further includes water, except the same mixture of the comparative example C. As illustrated in table 1 and FIG. 1, when the measuring times are between the first hour and the sixteenth hour ($T>1$ hr), the concentration of toluene of the comparative example C is 1232 ppm, and the concentration of toluene of the comparative example D is 938 ppm.

The concentration of toluene of the comparative example D is smaller than that of the comparative example C. When the measuring times are between the sixteenth hour and the twenty-fourth hour ($T > 16$ hr), the concentration of toluene of the comparative example D is 2689 ppm and the concentration of toluene of the comparative example C is 2870 ppm. The concentration of toluene of the comparative example D is obviously smaller than that of the comparative example C. As a result, the toluene absorption capacity of the composite of the comparative example D is better than that of the comparative example C.

[0023] A product of another embodiment according to the present invention is adapted to contact a biological substrate, wherein the product could deodorize instantly and be decomposed fast to form compost. The product includes the biodegradable composite mentioned above and a biodegradable plastic, wherein the biodegradable composite accounts for less than or equal to 10% of a weight of the product; the biodegradable plastic is decomposable by biological activities and contacts with the biodegradable composite.

[0024] In the current embodiment, the biodegradable plastic includes polylactic acid (PLA). In the current embodiment, the biodegradable plastic is mixed with the biodegradable composite.

[0025] In the current embodiment, the biodegradable plastic covers the biodegradable composite. In another embodiment, the biodegradable plastic encapsulates a part of the biodegradable composite, and the rest part of the biodegradable composite is attached to the biodegradable plastic. In the current embodiment, the product having the biodegradable composite could be a filter, a packaging material, a paper material, a cladding material, a package, a cladding structure, and a combination thereof.

[0026] In the current embodiments, the product has an identification code, wherein the identification code could be a two-dimensional code (QR code) and could be scanned by a user with a mobile communication device to connect to a blockchain for monitoring a location of the product. When the product is used and waste or garbage is produced, a related

company could recycle the product by itself with an assistance of blockchain technology to manage the recycling. Furthermore, after the product is recycled, additional biodegradable composite is added to the recycled product to accelerate a decomposition process of the recycled product. The recycled product is decomposed by the biodegradable composite to form a biobased compost which could be used as a fertilizer. After the product is decomposed, other remained wastes could be filtered to collect useful substances for reuse, thereby enhancing benefits of a circular economy.

[0027] The biodegradable composite and the product containing the biodegradable composite provided by the present invention could accelerate the speed of the decomposition process of the biodegradable plastic, suppress bad odors, and facilitate the decomposition process of the biowaste to form the matured biobased compost, thereby achieving the eco-friendly and sustainable goal. Moreover, according to the experiment result of the present invention proves the comparative example including the organic matter containing the viable bacterial and the activated carbon has better toluene absorption capacity than the comparative example merely including the activated carbon when each of the comparative examples has the same weight. Additionally, when the composites of the two comparative examples have the same components (namely both are including organic matter containing the viable bacterial, the activated carbon,), the comparative example with water has better toluene absorption capacity than the comparative example without water.

[0028] It must be pointed out that the embodiment described above is only a preferred embodiment of the present invention. All equivalent structures which employ the concepts disclosed in this specification and the appended claims should fall within the scope of the present invention.

WHAT IS CLAIMED IS:

1. A biodegradable composite, comprising:

an organic matter accounting for 40% to 80% of a weight of the biodegradable composite, wherein the organic matter comprises viable bacteria and has a total plate count that is greater than or equal to 10^4 CFU/g; and

a porous material accounting for 20% to 60 % of the weight of the biodegradable composite.

2. The biodegradable composite as claimed in claim 1, wherein the porous material is selected from a group consisting of activated carbon, eggshell powder, shell powder, bamboo charcoal powder, and a combination thereof.

3. The biodegradable composite as claimed in claim 1, wherein a weight ratio of the organic matter to the porous material is ranged from 0.6:1 to 1.2:1.

4. The biodegradable composite as claimed in claim 1, wherein the porous material has a plurality of pores, and the organic matter is filled into the plurality of pores; in per gram of the biodegradable composite, each of the plurality of pores of the porous material averagely contains 800 CFU to 1200 CFU of the viable bacteria.

5. The biodegradable composite as claimed in claim 1, wherein the viable bacteria are selected from a group consisting of thermophilic bacteria, *Bacillus coagulans*, *Bacillus subtilis*, *Bacillus thuringiensis*, *Pseudomonas putida*, Actinobacteria, and a combination thereof.

6. A product adapted to contact a biological substrate, comprising:

a biodegradable composite comprising an organic matter having viable bacteria and a porous material, wherein the organic matter accounts for 40% to 80% of a weight of the biodegradable composite, and a total plate count of the organic matter is greater than or equal to 10^4 CFU/g; the porous material accounts for 20% to 60 % of the weight of the biodegradable composite; the biodegradable composite accounts for less than or equal to

10% of a weight of the product; and

a biodegradable plastic that is decomposable by biological activities and contacts with the biodegradable composite.

7. The product as claimed in claim 6, wherein the biodegradable plastic comprises polylactic acid.

8. The product as claimed in claim 6, wherein the biodegradable plastic is mixed with the biodegradable composite.

9. The product as claimed in claim 6, wherein the biodegradable plastic covers the biodegradable composite.

10. The product as claimed in claim 6, wherein the biodegradable plastic encapsulates a part of the biodegradable composite, and the rest part of the biodegradable composite is attached to the biodegradable plastic.

11. The product as claimed in claim 6, wherein the product comprises a filter, a packaging material, a paper material, a cladding material, a package, a cladding structure, or a combination thereof.

12. The product as claimed in claim 6, comprising an identification code.

13. The product as claimed in claim 6, wherein during a recycling process of the product, additional biodegradable composite is added to the recycled product to allow the recycled product to be decomposed by the biodegradable composite to form a biobased compost.