US009410031B2

(12) **United States Patent**
Puhala et al.

(10) **Patent No.: US 9,410,031 B2**
(45) **Date of Patent: Aug. 9, 2016**

(54) **ORGANIC FUNCTIONALIZATION OF LAYERED DOUBLE HYDROXIDES**

(75) Inventors: **Aaron S. Puhala**, Kent, OH (US); **Xiaofan Luo**, Cleaveland, OH (US)

(73) Assignee: **Flow Polymers, LLC**, Cleveland, OH (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 174 days.

(21) Appl. No.: **13/528,092**

(22) Filed: **Jun. 20, 2012**

(65) **Prior Publication Data**

US 2013/0005871 A1 Jan. 3, 2013

Related U.S. Application Data

(60) Provisional application No. 61/502,005, filed on Jun. 28, 2011.

(51) **Int. Cl.**

C08K 5/098	(2006.01)
C08K 9/04	(2006.01)
C09C 1/42	(2006.01)
C08L 23/28	(2006.01)

(52) **U.S. Cl.**

CPC ***C08K 9/04*** (2013.01); ***C08L 23/283*** (2013.01); ***C09C 1/42*** (2013.01); *C01P 2002/72* (2013.01); *C01P 2002/82* (2013.01); *C01P 2002/88* (2013.01)

(58) **Field of Classification Search**

CPC C08K 9/04; C08L 23/283; C08L 7/00; C08L 21/00; A01N 59/04; A01N 2300/00; A01N 25/00; A01N 25/30; C01P 2002/72; C01P 2002/82; C01P 2002/88; C09C 1/42; C09C 3/08

USPC 524/71, 301, 313

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,786,202	B2	8/2010	Schomaker et al.	524/381
7,968,740	B2	6/2011	Winters et al.	556/182
8,551,743	B2 *	10/2013	Basheer	C11C 3/04 424/94.1
2008/0293849	A1	11/2008	Winters et al.	523/351
2011/0000632	A1	1/2011	Talma et al.	4/76

FOREIGN PATENT DOCUMENTS

IL	WO 2008084470	A2 *	7/2008	C11C 3/04
WO	WO 2007/065860	A1	6/2007	C08K 9/04
WO	WO 2007065860	A1 *	6/2007	

OTHER PUBLICATIONS

Rahman, Mohd et al. Immobilization of Lipase from Candida rugosa on Layered Double Hydroxides of Mg/Al and its Nanocomposite as Biocatalyst for the Synthesis of Ester. Catalysis Today 93-95 (2004). Elsevier. pp. 405-410.*

* cited by examiner

Primary Examiner — Kagnew H Gebreyesus
Assistant Examiner — Nghi Nguyen
(74) *Attorney, Agent, or Firm* — Alvin T. Rockhill

(57) **ABSTRACT**

The present invention relates to a method for preparing an organically functionalized layered double hydroxide which comprises reacting (a) a layered double hydroxide, (b) a triglyceride oil, (c) an enzyme which is capable of catalyzing the hydrolysis of an ester, and (d) water, to produce the organically functionalized layered double hydroxide. The subject invention further reveals a method for preparing an organically functionalized layered double hydroxide which comprises (1) dispersing into an aqueous medium (a) the layered double hydroxide, (b) the triglyceride oil, and (c) the enzyme, (2) allowing the triglyceride oil to hydrolyze into long-chain fatty acids and glycerol to produce a dispersion of the organically functionalized layered double hydroxide; and (3) recovering the organically functionalized layered double hydroxide from the aqueous dispersion.

12 Claims, 7 Drawing Sheets