US009993579B2

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

(10) **Patent No.: US 9,993,579 B2**
(45) **Date of Patent: Jun. 12, 2018**

(54) **POLYURETHANES FOR OSTEOIMPLANTS**

(71) Applicant: **Warsaw Orthopedic, Inc.**, Warsaw, IN (US)

(72) Inventors: **David Knaack**, Summit, NJ (US); **John Winterbottom**, Dundee, MI (US); **David R. Kaes**, Toms River, NJ (US); **Todd M. Boyce**, Collierville, TN (US); **Lawrence A. Shimp**, Burlington, WI (US)

(73) Assignee: **Warsaw Orthopedic, Inc.**, Warsaw, IN (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days. days.

(21) Appl. No.: **15/643,137**

(22) Filed: **Jul. 6, 2017**

(65) **Prior Publication Data**

US 2017/0304496 A1 Oct. 26, 2017

Related U.S. Application Data

(63) Continuation of application No. 15/144,139, filed on May 2, 2016, now Pat. No. 9,789,223, which is a continuation of application No. 13/867,689, filed on Apr. 22, 2013, now Pat. No. 9,327,052, which is a continuation of application No. 13/181,715, filed on Jul. 13, 2011, now Pat. No. 8,425,893, which is a continuation of application No. 10/771,736, filed on Feb. 4, 2004, now Pat. No. 8,002,843.

(60) Provisional application No. 60/444,759, filed on Feb. 4, 2003.

(51) **Int. Cl.**

A61K 31/74	(2006.01)
A61F 13/00	(2006.01)
A61L 27/36	(2006.01)
C08G 18/10	(2006.01)
C08G 18/38	(2006.01)
C08G 18/64	(2006.01)
C08G 18/73	(2006.01)
C08G 18/77	(2006.01)
C08G 18/79	(2006.01)
A61L 27/46	(2006.01)
A61L 27/58	(2006.01)
A61L 27/54	(2006.01)
A61L 27/18	(2006.01)
C08L 75/04	(2006.01)

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

CPC ***A61L 27/3608*** (2013.01); ***A61L 27/18*** (2013.01); ***A61L 27/46*** (2013.01); ***A61L 27/54*** (2013.01); ***A61L 27/58*** (2013.01); ***C08G 18/10*** (2013.01); ***C08G 18/3878*** (2013.01); ***C08G 18/3882*** (2013.01); ***C08G 18/6484*** (2013.01); ***C08G 18/73*** (2013.01); ***C08G 18/771*** (2013.01); ***C08G 18/798*** (2013.01); ***C08L 75/04*** (2013.01); *A61L 2300/414* (2013.01); *A61L 2300/426* (2013.01); *A61L 2430/02* (2013.01); *C08G 2230/00* (2013.01)

(58) **Field of Classification Search**

CPC A61K 31/74; A61F 13/00
USPC 424/78.27, 422
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,882,249	A	4/1959	Posnansky	525/111
4,477,604	A	10/1984	Oechsle, III	
4,570,270	A	2/1986	Oechsle, III	
4,698,318	A	10/1987	Vogel et al.	
4,829,099	A	5/1989	Fuller et al.	
4,880,610	A	11/1989	Constantz	
RE33,161	E	2/1990	Brown et al.	
4,902,508	A	2/1990	Badylak et al.	
RE33,221	E	5/1990	Brown et al.	
5,034,059	A	7/1991	Constantz	
5,047,031	A	9/1991	Constantz	
5,053,212	A	10/1991	Constantz	
5,116,550	A	5/1992	Perkins	
5,129,905	A	7/1992	Constantz	
5,149,368	A	9/1992	Liu et al.	
5,243,038	A	9/1993	Ferrari et al.	
5,262,166	A	11/1993	Liu et al.	
5,263,984	A	11/1993	Li et al.	
5,336,264	A	8/1994	Constantz et al.	
5,462,722	A	10/1995	Liu et al.	
5,507,810	A	4/1996	Prewett et al.	
5,525,148	A	6/1996	Chow et al.	
5,542,973	A	8/1996	Chow et al.	
5,578,086	A	11/1996	Prescott	
5,605,713	A	2/1997	Boltong et al.	
5,607,269	A	3/1997	Dowd et al.	
5,650,176	A	7/1997	Lee et al.	

(Continued)

FOREIGN PATENT DOCUMENTS

DE	19546367	A1	6/1997
DE	19546371	A1	6/1997

(Continued)

OTHER PUBLICATIONS

International Search Report PCT/2004/001200 dated Sep. 30, 2004.
Supplementary European Search Report Application No. EP 07 71 8273.
Tissue Engineering and Biodegradable Equivalents Scientific and Clinical Applications, Lewandrowski et al., Copyright 2002, Marcel Dekker, Inc., see chapter 7.
Reexamination of Knaack et al., U.S. Pat. No. 7,985,414 (Apr. 12, 2012) Application/Control No. 90/012,251.

(Continued)

Primary Examiner — Raymond J Henley, III

(57) **ABSTRACT**

Biological-based polyurethanes and methods of making the same. The polyurethanes are formed by reacting a biodegradable polyisocyanate (such as lysine diisocyanate) with an optionally hydroxylated biomolecule to form polyurethane. The polymers formed may be combined with ceramic and/or bone particles to form a composite, which may be used as an osteoimplant.

20 Claims, No Drawings