US005410016A

United States Patent [19]

Hubbell et al.

[11] **Patent Number: 5,410,016**

[45] **Date of Patent: Apr. 25, 1995**

[54] **PHOTOPOLYMERIZABLE BIODEGRADABLE HYDROGELS AS TISSUE CONTACTING MATERIALS AND CONTROLLED-RELEASE CARRIERS**

[75] Inventors: **Jeffrey A. Hubbell**, Austin, Tex.; **Chandrashekhar P. Pathak**, Waltham; **Amarpreet S. Sawhney**, Newton, both of Mass.; **Neil P. Desai**, Los Angeles, Calif.; **Jennifer L. Hill**, Austin, Tex.

[73] Assignee: **Board of Regents, The University of Texas System**, Austin, Tex.

[21] Appl. No.: **22,687**

[22] Filed: **Mar. 1, 1993**

Related U.S. Application Data

[60] Continuation-in-part of Ser. No. 843,485, Feb. 28, 1992, abandoned, Ser. No. 598,880, Oct. 15, 1990, and Ser. No. 740,703, Aug. 5, 1991, which is a division of Ser. No. 598,880, Aug. 5, 1991.

[51] **Int. Cl.**[6] **C08G 63/08**; C08G 67/00; A61K 9/58

[52] **U.S. Cl.** **528/354**; 128/898; 424/426; 424/489; 525/54.1; 525/54.2; 525/408; 525/413; 525/415; 514/772.1; 514/772.3; 514/773; 514/777; 528/361

[58] **Field of Search** 424/426, 489; 514/772.1, 772.3, 773, 777; 525/54.1, 54.2, 408, 413, 415; 528/354, 361; 128/898

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,640,741	2/1972	Etes	424/401
3,925,895	12/1975	Kliment et al. .	
3,960,150	6/1976	Hussain et al. .	
3,981,303	9/1976	Higuchi et al. .	
3,986,510	10/1976	Higuchi et al. .	
3,993,071	11/1976	Higuchi et al. .	
4,076,800	2/1978	Marsh et al. .	
4,080,969	3/1978	Casey et al.	606/230
4,095,600	6/1978	Casey et al.	606/230
4,118,470	10/1978	Casey et al.	606/230
4,193,845	3/1980	Kaetsu et al. .	
4,194,066	3/1980	Kaetsu et al. .	
4,195,129	3/1980	Fukui et al. .	
4,226,938	10/1980	Yoshida et al. .	
4,272,617	6/1981	Kaetsu et al. .	
4,295,762	10/1981	Slovinsky .	
4,298,002	11/1981	Ronel et al. .	

(List continued on next page.)

FOREIGN PATENT DOCUMENTS

0195304	9/1986	European Pat. Off. .
0399441	11/1990	European Pat. Off. .
0466648	1/1992	European Pat. Off. .

(List continued on next page.)

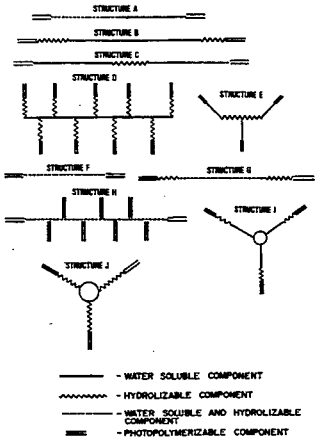
OTHER PUBLICATIONS

Zhu, K. J., et al., "Preparation and Properties of D,L-Lactide and Ethylene Oxide Copolymer: A Modifying Biodegradable Polymeric Material," *J. Polymer Sci., Part C: Polymer Letters,* 24:331–337 (Aug. 1986).

(List continued on next page.)

Primary Examiner—Morton Foelak
Assistant Examiner—Shelley A. Dodson
Attorney, Agent, or Firm—Kilpatrick & Cody

[57] **ABSTRACT**

Hydrogels of polymerized and crosslinked macromers comprising hydrophilic oligomers having biodegradable monomeric or oligomeric extensions, which biodegradable extensions are terminated on free ends with end cap monomers or oligomers capable of polymerization and cross linking are described. The hydrophilic core itself may be degradable, thus combining the core and extension functions. Macromers are polymerized using free radical initiators under the influence of long wavelength ultraviolet light, visible light excitation or thermal energy. Biodegradation occurs at the linkages within the extension oligomers and results in fragments which are non-toxic and easily removed from the body. Preferred applications for the hydrogels include prevention of adhesion formation after surgical procedures, controlled release of drugs and other bioactive species, temporary protection or separation of tissue surfaces, adhering of sealing tissues together, and preventing the attachment of cells to tissue surfaces.

23 Claims, 9 Drawing Sheets