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(54) **ORGANIC LIGHT-EMITTING DIODES AND METHODS FOR ASSEMBLY AND EMISSION CONTROL**

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(58) **Field of Search** 428/690, 917, 428/446, 447, 448, 450; 313/504, 506; 427/66

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,172,862 A		3/1965	Gurnee et al.	
3,173,050 A		3/1965	Gurnee	
3,567,450 A		3/1971	Brantly et al.	
3,658,520 A		4/1972	Brantly et al.	
3,710,167 A		1/1973	Dresner et al.	
4,539,507 A		9/1985	Van Slyke et al.	313/504
4,769,292 A		9/1988	Tang et al.	428/69
5,130,603 A		7/1992	Tokailin et al.	313/504
5,151,629 A		9/1992	Van Slyke	313/504
5,156,918 A		10/1992	Marks et al.	428/447
5,276,381 A		1/1994	Waklimoto et al.	313/504
5,336,546 A		8/1994	Hironaka et al.	428/209
5,409,703 A		4/1995	McAnalley et al.	424/435
5,409,783 A		4/1995	Tang et al.	428/690
5,414,069 A		5/1995	Cumming et al.	528/310
5,457,357 A		10/1995	Fujii et al.	313/506
5,834,100 A	*	11/1998	Marks et al.	428/209
6,165,383 A	*	12/2000	Chou	252/301.16

OTHER PUBLICATIONS

Advanced Materials, 1997, 9, No. 3, pp. 222–225, by Frank Niesch et al., "Derivatized Electrodes in the Construction of Organic Light Emitting Diodes". (No month).

Advanced Materials, 1999, 11, No. 2, pp. 107–112, by Morais et al., "Hybrid Organic–Inorganic Light–Emmitting Diodes". (No month).

Appl. Phys. Lett. vol. 74, No. 15, Apr. 12, 1999, by Deng et al., "Enhanced Brightness and Efficiency in Organic Electrouminescent Devices using SiO_2 Buffer layers".

* cited by examiner

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(57) **ABSTRACT**

New organic light-emitting diodes and related electroluminescent devices and methods for fabrication, using siloxane self-assembly techniques.

25 Claims, 9 Drawing Sheets