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(12) **United States Patent**
Miller

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(54) **FUNCTIONAL AND REUSABLE
ELECTRODEPOSITED COATINGS ON
POROUS MEMBRANES**

(58) **Field of Classification Search**
CPC C23C 18/1633–18/1648; C23C 18/1689;
C25D 5/48

See application file for complete search history.

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(56) **References Cited**

U.S. PATENT DOCUMENTS

5,538,642 A 7/1996 Solie
5,683,916 A 11/1997 Goffe et al.

(Continued)

FOREIGN PATENT DOCUMENTS

FR WO 2009109727 A1 * 9/2009 B81C 1/00206
JP H06238141 8/1994

(Continued)

OTHER PUBLICATIONS

Author Unknown, "Mustang® Membrane Devices for Ion Exchange Chromatography", Pall Corporation, http://www.pall.com/laboratory_7001.asp, Jan. 2010, 2 pages.

(Continued)

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(57) **ABSTRACT**

Functionalized membranes for use in applications, such as electrodeionization, can be prepared simply and efficiently by coating a conductive carbon nanotube and polymer membrane with a metal layer; and contacting the coated membrane with a solution comprises at least one electrochemically active and functional compound under conditions suitable for electrochemically depositing the electrochemically active and function compound on a surface of the metal-coated membrane. Such membranes may be reversible modified by chemically or electrochemically oxidizing the metal layer from the polymer membrane surface, thereby, providing a fresh surface which may be re-modified according to the preceding methods.

24 Claims, 3 Drawing Sheets

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