US006818291B2

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

(10) **Patent No.: US 6,818,291 B2**
(45) **Date of Patent: Nov. 16, 2004**

(54) **DURABLE TRANSPARENT EMI SHIELDING FILM**

(75) Inventors: **Arnold William Funkenbusch**, Mahtomedi, MN (US); **Clark Ivan Bright**, Tucson, AZ (US); **Robert James Fleming**, Saint Paul, MN (US)

(73) Assignee: **3M Innovative Properties Company**, St. Paul, MN (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.

(21) Appl. No.: **10/222,465**

(22) Filed: **Aug. 17, 2002**

(65) **Prior Publication Data**

US 2004/0033384 A1 Feb. 19, 2004

(51) **Int. Cl.**[7] **B32B 15/04**; B32B 15/08; H05K 5/00; H05K 9/00

(52) **U.S. Cl.** **428/336**; 428/626; 428/457; 428/673; 428/460; 174/51; 361/818

(58) **Field of Search** 428/626, 673, 428/686, 457, 460, 929, 336; 174/6, 51; 361/818; 257/508, 659

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,302,002	A	1/1967	Warren	219/543
3,311,517	A	3/1967	Keslar et al.	156/104
3,529,074	A	9/1970	Lewis	174/68.5

(List continued on next page.)

FOREIGN PATENT DOCUMENTS

EP	0 810 452	A2	12/1997
EP	0873839	A1	10/1998
EP	0944299 A2	A3	9/1999
EP	0977167	A1	2/2000
WO	WO 95/10117		4/1995
WO	WO 97/01440		1/1997
WO	WO 97/01778		1/1997
WO	WO 97/04885		2/1997
WO	WO 98/26927		6/1998
WO	WO 99/36248		7/1999
WO	WO 99/36262		7/1999
WO	WO 00/26973		5/2000
WO	WO 00/48749		8/2000
WO	WO 01/31393	A1	5/2001
WO	WO 01/58989	A1	8/2001
WO	WO 01/96104	A2	12/2001
WO	WO 01/96115	A1	12/2001

OTHER PUBLICATIONS

H.G. Elias, "An Introduction to Plastics," VCH Verlagsgesellaschaft mbH (Weinheim, Germany), 1993, no month, p. 249.*

U.S. patent application Ser. No. 10/222,466, Polymer–Metal Infrared Interference Filter, filed Aug. 17, 2002.

U.S. patent application Ser. No. 10/222,473, Enhanced Heat Mirror Films, filed Aug. 17, 2002.

U.S. patent application Ser. No. 10/222,449, Flexible Electrically Conductive Film, filed Aug. 17, 2002.

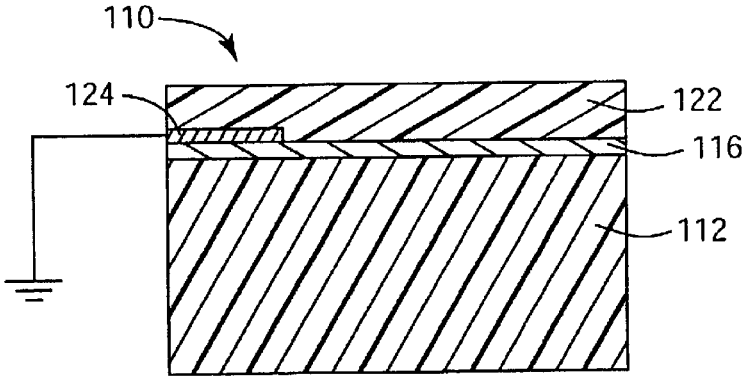
Presentation: Affinito et al., "Polymer–Oxide Transparent Barrier Layers," SVC 39th Annual Technical Conference, Paper No. W–12, (1996), pp. 1–6, no month.

Presentation: Shaw et al., "A New Vapor Deposition Process for Coating Paper and Polymer Webs," Sixth International Vacuum Web Coating Conference, Reno, NV, Oct. 28, 1992, pp. 18–24.

(List continued on next page.)

Primary Examiner—Michael La Villa
(74) *Attorney, Agent, or Firm*—Melanie G. Gover; Pamela L. Stewart

(57) **ABSTRACT**

A device or an enclosed area that can cause or is sensitive to electromagnetic interference (EMI) is shielded by at least partially surrounding the device or the area with a visible light-transmissive film comprising a flexible support, an extensible visible light-transmissive metal or metal alloy layer and a visible light-transmissive crosslinked polymeric protective layer, and connecting at least one grounding electrode to the metal or metal alloy layer. The film has reduced susceptibility to fracture or corrosion compared to commercially available EMI shielding films.

27 Claims, 6 Drawing Sheets