US006852416B2

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

(10) **Patent No.: US 6,852,416 B2**
(45) **Date of Patent: Feb. 8, 2005**

(54) **HIGH DIELECTRIC CONSTANT COMPOSITES OF METALLOPHTHALAOCYANINE OLIGOMER AND POLY (VINYLIDENE-TRIFLUOROETHYLENE) COPOLYMER**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 78 days.

(21) Appl. No.: **10/121,936**

(22) Filed: **Apr. 12, 2002**

(65) **Prior Publication Data**

US 2002/0161074 A1 Oct. 31, 2002

Related U.S. Application Data

(63) Continuation-in-part of application No. 10/108,231, filed on Mar. 27, 2002, now Pat. No. 6,787,238.

(60) Provisional application No. 60/283,755, filed on Apr. 13, 2001.

(51) **Int. Cl.**[7] **B32B 27/18**; C08L 27/16; H01L 51/30

(52) **U.S. Cl.** **428/421**; 257/40; 524/81; 524/88; 524/544; 524/545; 524/546

(58) **Field of Search** 428/421; 257/40; 524/81, 88, 544, 545, 546

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,069,244 A * 5/2000 Masuda et al. 540/139
6,480,370 B1 * 11/2002 Koning et al. 361/321.2

OTHER PUBLICATIONS

Ferroelectrics, 1990, vol. 109, pp. 303–308, F. Macchi et al. "Effect of Electron Irradiation on the Ferroelectric Transition of P (VDF–TrFE) Copolymers".

Macromolecules 1985, vol. 18, pp. 910–918, Andrew J. Lovinger, "Polymorphic Transformations in Ferroelectric Copolymers of Vinylidene Fluoride Induced by Electron Irradiation".

Nuclear Instruments and Methods in Physics Research, B46 (1990), pp. 334–337, F. Macchi et al., "Micromechanical Properties of Electron Irradiated PVDF–TrFE Copolymers".

* cited by examiner

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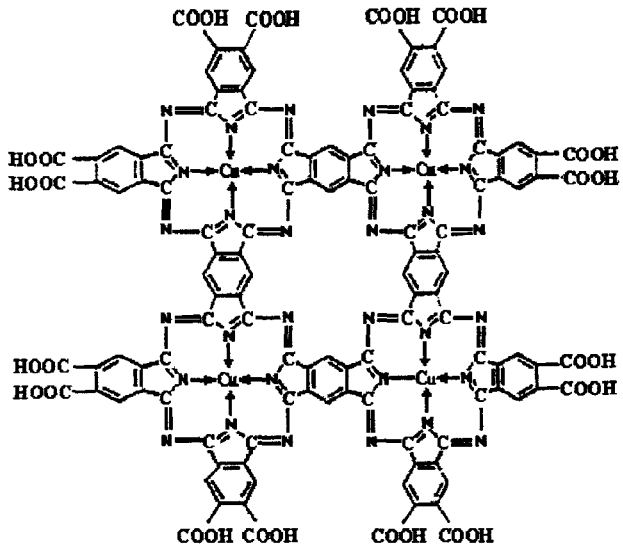
(57) **ABSTRACT**

There are disclosed new composite materials having improved electric field induced strain levels, improved electric constants, and having advantageous mechanical properties for use in electrical devices.

29 Claims, 6 Drawing Sheets