

University of Nebraska - Lincoln

DigitalCommons@University of Nebraska - Lincoln

Patents Held by Members of the Department of
Chemical and Biomolecular Engineering

Chemical and Biomolecular Engineering Research
and Publications

April 2003

Ferroelectric Storage Read-Write Memory

Dr.Ravi Saraf

University of Nebraska-Lincoln, rsaraf2@unl.edu

Follow this and additional works at: <http://digitalcommons.unl.edu/chemengpatent>



Part of the [Chemical Engineering Commons](#)

Saraf, Dr.Ravi, "Ferroelectric Storage Read-Write Memory" (2003). *Patents Held by Members of the Department of Chemical and Biomolecular Engineering*. 64.

<http://digitalcommons.unl.edu/chemengpatent/64>

This Article is brought to you for free and open access by the Chemical and Biomolecular Engineering Research and Publications at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Patents Held by Members of the Department of Chemical and Biomolecular Engineering by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.



US006548843B2

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

(10) **Patent No.:** **US 6,548,843 B2**
(45) **Date of Patent:** ***Apr. 15, 2003**

(54) **FERROELECTRIC STORAGE READ-WRITE MEMORY**

(75) Inventors: **Hemantha K. Wickramasinghe**,
Chappaqua, NY (US); **Ravi F. Saraf**,
Briar Cliff Manor, NY (US)

(73) Assignee: **International Business Machines Corporation**, Armonk, NY (US)

(*) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

5,119,329 A	*	6/1992	Evans, Jr. et al.	365/145
5,329,485 A		7/1994	Isono et al.	365/145
5,341,325 A	*	8/1994	Nakano et al.	365/145
5,342,452 A		8/1994	Saito et al.	136/256
5,343,353 A	*	8/1994	Miki et al.	361/322
5,349,238 A		9/1994	Ohsawa et al.	257/736
5,432,379 A		7/1995	Eguchi et al.	257/627
5,457,343 A		10/1995	Ajayan et al.	257/734
5,541,422 A	*	7/1996	Wolf et al.	257/9
5,631,664 A	*	5/1997	Adachi et al.	345/74.1
5,658,802 A		8/1997	Hayes et al.	436/518
5,670,827 A		9/1997	Sakuma et al.	257/741
5,717,235 A	*	2/1998	Gendlin	257/295
5,736,759 A	*	4/1998	Haushalter	257/295
5,737,180 A	*	4/1998	Yoo	361/313
5,822,240 A	*	10/1998	Yoo	365/145
6,150,184 A	*	11/2000	Evans et al.	438/3

OTHER PUBLICATIONS

Braun, Erez et al., "DNA-templated assembly and electrode attachment of a conducting silver wire", *Nature*, vol. 391, Feb. 19, 1998, pp. 775-777.

(List continued on next page.)

(21) Appl. No.: **09/190,131**

(22) Filed: **Nov. 12, 1998**

(65) **Prior Publication Data**

US 2002/0089005 A1 Jul. 11, 2002

(51) **Int. Cl.**⁷ **H01L 29/76**

(52) **U.S. Cl.** **257/295; 257/298; 365/145**

(58) **Field of Search** **257/295, 298, 257/310; 365/145**

(56) **References Cited**

U.S. PATENT DOCUMENTS

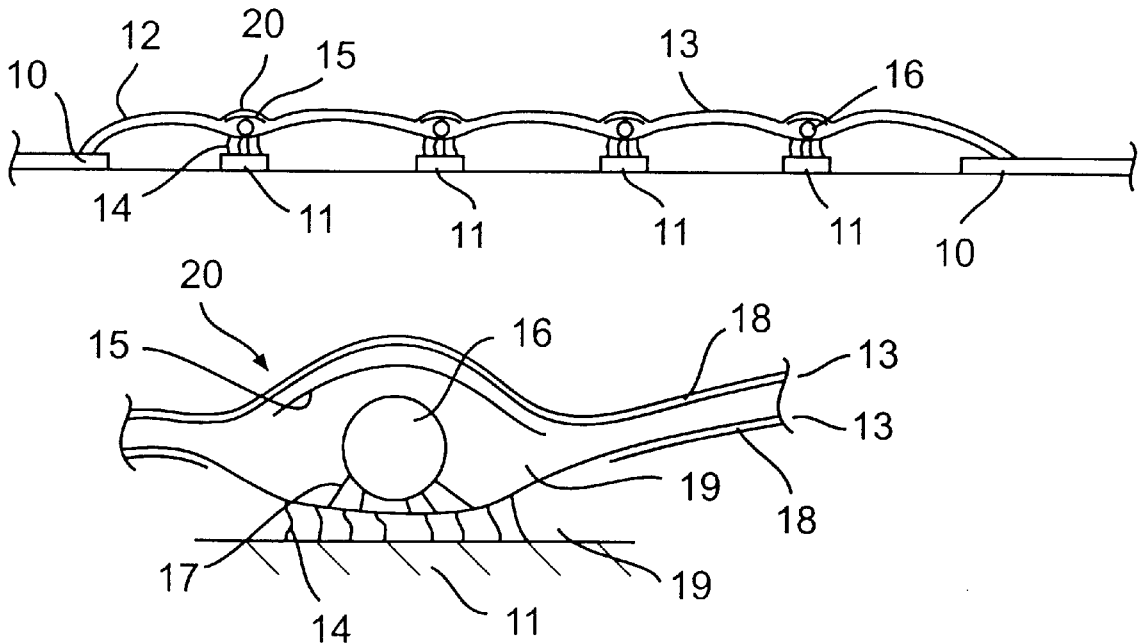
4,972,370 A * 11/1990 Morimoto et al. 365/106

Primary Examiner—George Eckert
(74) *Attorney, Agent, or Firm*—Connolly Bove Lodge & Hutz, LLP; Robert M. Trepp, Esq.

(57) **ABSTRACT**

A memory device including at least one pair of spaced apart conductors and a ferroelectric material between the pair of conductors. The pair of conductors is spaced apart a distance sufficient to permit a tunneling current therebetween.

91 Claims, 4 Drawing Sheets



OTHER PUBLICATIONS

Kajiyama, T. et al., "Electric field induced structural change for poly(vinylidene fluoride co trifluoroethylene) ultrathin films studied by scanning Maxwell stress microscope", J. Vac. Sci. Technol. B, Microelectron Nanometer Struct. (USA), vol. 16, No. 1, Jan. Feb. 1998, P. 121-4, Conference, Fourth International Workshop on the Measurement, Characterization, and Modeling of Ultra Shallow Doping Profiles in Semiconductors. Abstract.

The Quantum Dot: A Journey Into the Future of Microelectronics, Richard Turton, 1995.

Quantum Functional Devices: Present Status and Future Prospects, A.C. Seabaugh, et al. (p. 9-21), 1993.

Reviews of Modern Physics, vol. 64, No. 3, Jul. 1992, The single-electron transistor (p. 849-858).

Journal of Bacteriology, vol. 176, No. 7, Apr. 1994, Minireview, D-Loops and R-Loops: Alternative Mechanisms for the Initiation of Chromosome Replication in *Escherichia coli* (p. 1807-1812).

Nucleic Acids Research, 1995, vol. 23, No. 17, Double stranded scission of DNA directed through sequence-specific R-loop formation, Ralf Landgraf, et al.

Nucleic Acids Research, 1995, vol. 23, No. 17, R-loop stability as a function of RNA structure and size, Ralf Landgraf, et al. (p. 3516-3523).

Biochimie (1996) 78, Mechanisms of primer RNA synthesis and D-loop/R-loop-dependent DNA replication in *Escherichia coli* (p. 1109-1117).

* cited by examiner

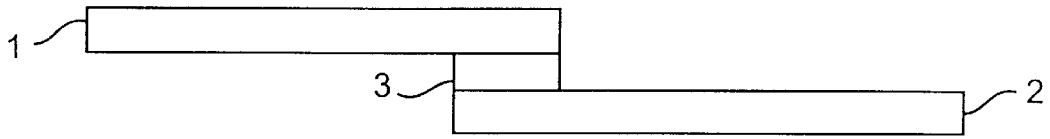


FIG. 1

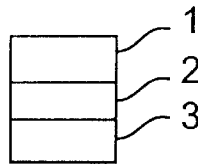


FIG. 1(a)

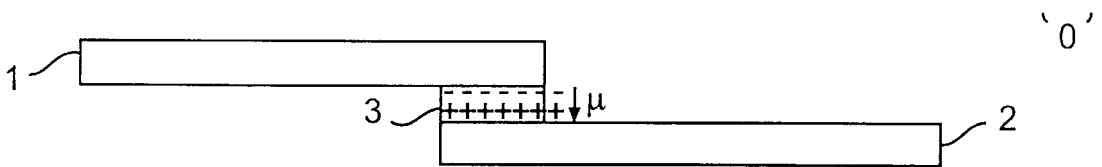


FIG. 2(a)

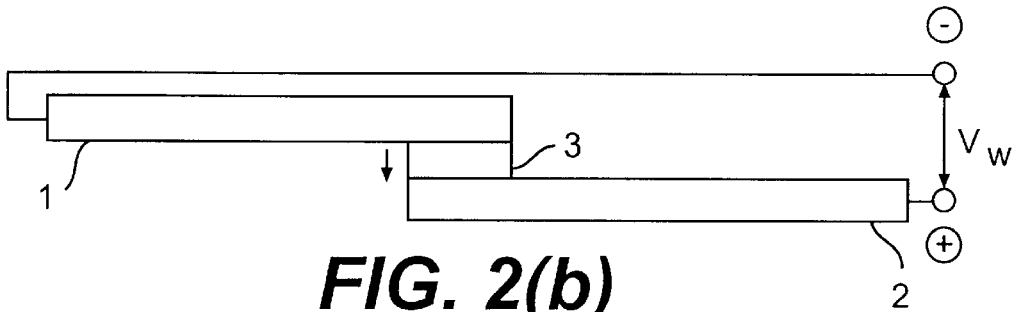


FIG. 2(b)

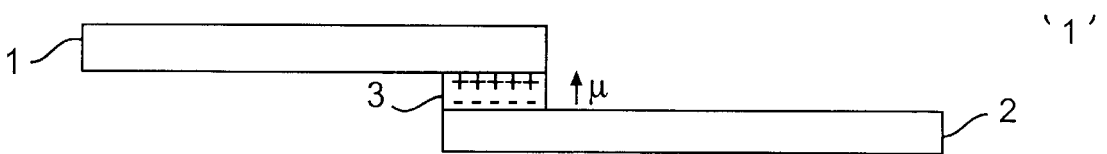


FIG. 2(c)

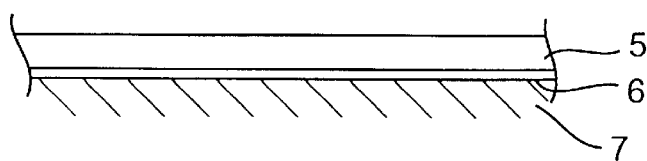


FIG. 3(a)

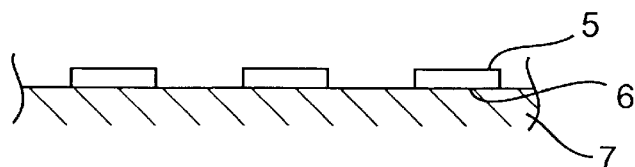


FIG. 3(b)

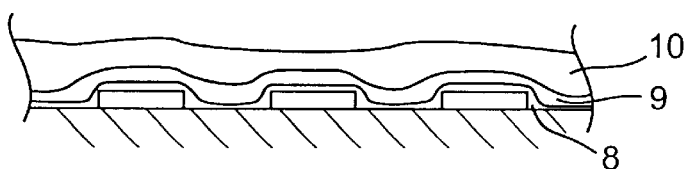


FIG. 3(c)

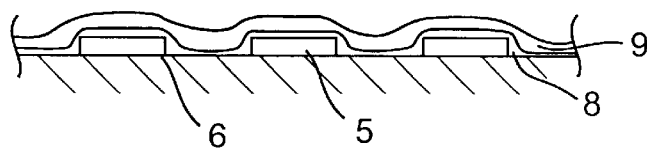


FIG. 3(d)

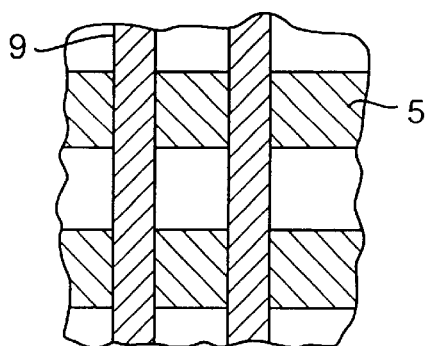


FIG. 4

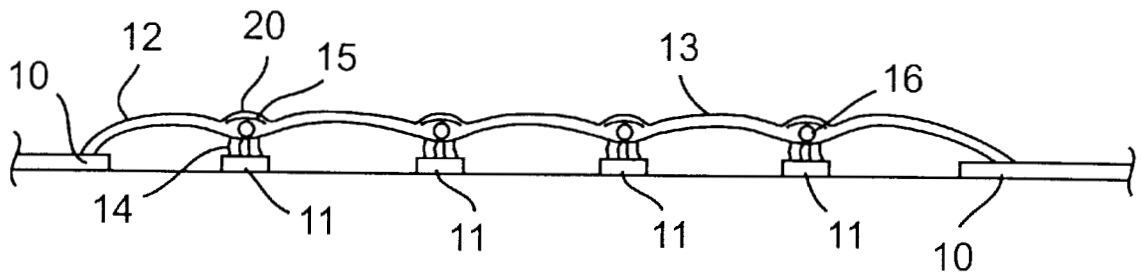


FIG. 5

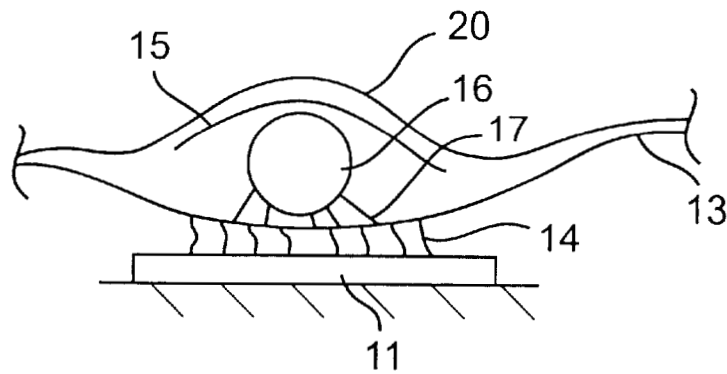


FIG. 6

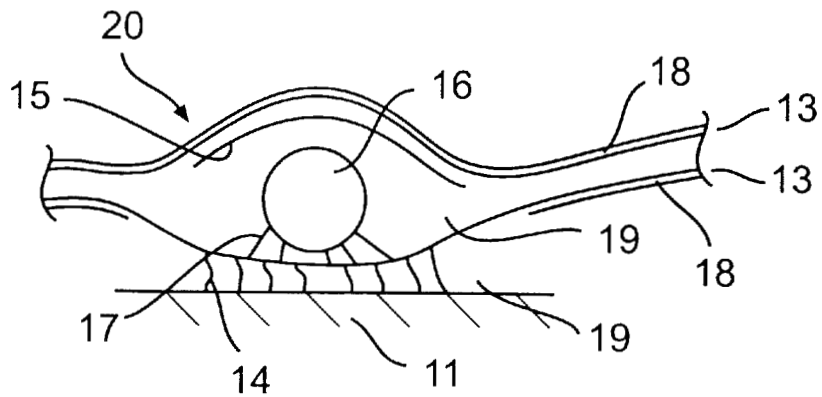


FIG. 7

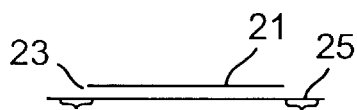


FIG. 8

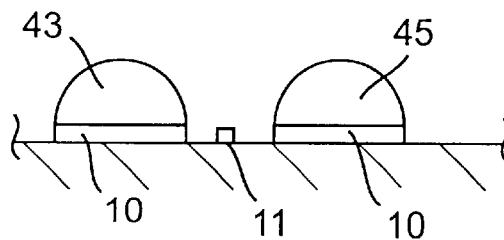


FIG. 9