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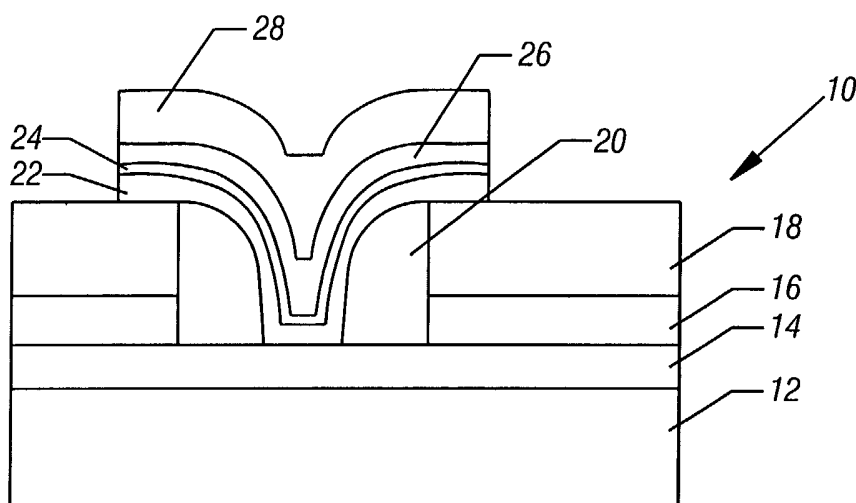
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(54) Title: MUTIPLE LAYER PHASE-CHANGE MEMORY



(57) Abstract: A phase-change memory (10) may be formed with at least two phase-change material layers (22, 26) separated by a barrier layer (24). The use of more than one phase-change layer (22, 26) enables a reduction in the programming volume while still providing adequate thermal insulation.

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INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 02/26374

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 H01L45/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H01L G11C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 957 477 A (MATSUSHITA ELECTRIC INDUSTRIAL CO LTD) 17 November 1999 (1999-11-17)  paragraph '0022! - paragraph '0040!; figure 2 paragraph '0070! - paragraph '0074!	1-4, 10-14, 31, 32, 34-36
X	WO 98 19350 A (ENERGY CONVERSION DEVICES INC) 7 May 1998 (1998-05-07)  page 12, line 26 -page 18, line 4; figure 1  ----- -/--	1, 2, 5, 10, 11, 13, 15-17

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

° Special categories of cited documents:

\*A\* document defining the general state of the art which is not considered to be of particular relevance

\*E\* earlier document but published on or after the international filing date

\*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

\*O\* document referring to an oral disclosure, use, exhibition or other means

\*P\* document published prior to the international filing date but later than the priority date claimed

\*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

\*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

\*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

\*G\* document member of the same patent family

Date of the actual completion of the international search

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## INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 02/26374

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 920 788 A (REINBERG ALAN R) 6 July 1999 (1999-07-06)  column 3, line 29 -column 5, line 65; claims; figure 2 ---	1,2,5, 21,24, 26,28,29
X	US 3 801 966 A (TERAO M) 2 April 1974 (1974-04-02) column 1, line 46 -column 3, line 4; figure 1; example 2 ---	21,24,25
A	US 5 952 671 A (REINBERG ALAN R ET AL) 14 September 1999 (1999-09-14) column 7, line 36 -column 9, line 9; claim 15; figures 5-12 ---	1,5-10, 15-18
P,X	EP 1 202 285 A (MATSUSHITA ELECTRIC INDUSTRIAL CO LTD) 2 May 2002 (2002-05-02)  paragraph '0046! - paragraph '0061!; figure 1 -----	1,3,4, 10-12, 14,15, 31,32, 34,35

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US 02/26374

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.:  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
  
3.  Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1.  As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2.  As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3.  As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4.  No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

### Remark on Protest

- The additional search fees were accompanied by the applicant's protest.
- No protest accompanied the payment of additional search fees.

**FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210**

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-20, 31-36

Memory cell comprising first and second phase-change material layers and a non-phase-change material layer (conductor) between said layers, and method of manufacturing

2. Claims: 21-30

Memory cell comprising first and second phase-change material layers, only one of said layers being programmable

## INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 02/26374

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 0957477	A	17-11-1999	CN 1236156 A	24-11-1999
			EP 0957477 A2	17-11-1999
			JP 3250989 B2	28-01-2002
			JP 2000036130 A	02-02-2000
			JP 2001273674 A	05-10-2001
			TW 448435 B	01-08-2001
			US 6456584 B1	24-09-2002
WO 9819350	A	07-05-1998	US 5825046 A	20-10-1998
			AU 4827197 A	22-05-1998
			EP 0947005 A1	06-10-1999
			JP 2001502848 T	27-02-2001
			KR 2000052840 A	25-08-2000
			US 6087674 A	11-07-2000
			WO 9819350 A1	07-05-1998
US 5920788	A	06-07-1999	US 5789758 A	04-08-1998
US 3801966	A	02-04-1974	JP 986350 C	07-02-1980
			JP 48091940 A	29-11-1973
			JP 54023539 B	14-08-1979
			JP 48028147 A	13-04-1973
			JP 52021335 B	09-06-1977
			US 3641510 A	08-02-1972
US 5952671	A	14-09-1999	US 6189582 B1	20-02-2001
			US 2001002046 A1	31-05-2001
EP 1202285	A	02-05-2002	CN 1351379 A	29-05-2002
			EP 1202285 A2	02-05-2002
			JP 2002203392 A	19-07-2002
			US 2002131309 A1	19-09-2002