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11/941,785 16 November 2007 (16.11.2007) US(71) Applicant (for all designated States except US): **ENDEVCO CORPORATION** [US/US]; 30700 Rancho Viejo Road, Suite B, San Juan Capistrano, CA 92675 (US).

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3 December 2009

(54) Title: HIGH TEMPERATURE PIEZOELECTRIC CERAMICS AND SENSORS MADE OF THE SAME FOR DYNAMIC MEASUREMENTS

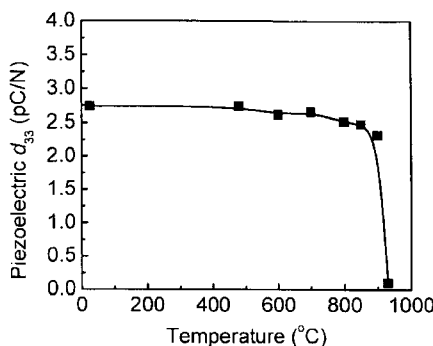


Figure 1.

Temperature dependence of piezoelectric coefficient d_{33} of one of the materials in the invention.(57) Abstract: The present invention is directed to a new group of pure and doped bismuth layer structured perovskite high temperature piezoelectric ceramics and sensors made of the same. The new materials have the formula of $[\text{Bi}_2\text{O}_2][\text{A}_{m-1}\text{B}_m\text{O}_{3m+1}]$, where $m=2$, A is mono-, di-, or trivalent ions or a combination of them, B is transition elements such as Fe^{3+} , Ti^{4+} , Nb^{5+} , Ta^{5+} , W^{6+} , Mo^{6+} or a combination of them. The ceramics have high Curie temperature of 900~940 °C. The sensors claimed in the present invention utilize $[\text{Bi}_2\text{O}_2][\text{A}_{m-1}\text{B}_m\text{O}_{3m+1}]$ ceramics parts as sensing elements in various shapes and dimensions and can be used to sense force, acceleration, and pressure at very high temperatures.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 08/83599

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - H01L 41/04; C04B 35/46 (2009.01)

USPC - 252/62.9PZ; 252/62.9R

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)
252/62.9PZ; 252/62.9R; 310/346; 29/25.35

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 practicable, search terms used)

Date Bases: Pubwest (PGPB, USPT, EPAB, JPAB); Google Patents, Google Scholar

Terms: bismuth, Bi, Bi2O2, perovskite, ceramic, piezoelectric, Am-1BmO3m+1, milling, calcination, fire methods, doped, dopant, curie temperature, Tc, polarization, electric field

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	6,218,233 B1 (TAKEMURA) 17 April 2001 (17.04.2001) col 6, 25-31; col 6, ln 32-43	1, 2, and 4
Y		3, and 5-6
Y	3,649,539 (APFEL et al.) 14 March 1972 (14.03.1972) col 4, ln 7-16; col 4, ln 19-22; col 4, ln 40-41	3, and 5-6
Y	TAKEDA et al., "Enhanced piezoelectric properties of off-stoichiometric strontium bismuth tantalate Sr0.8Bi2.2Ta2O9 ceramics", Applied Physics A, June 2005, Volume 81, Number 1, pp 131-135 (pp 2787, col1, para 2; pp 2787, col 2, para 2)	5-6
Y	YAN et al., "B-site donor and acceptor doped Aurivillius phase Bi3NbTiO9 ceramics", Journal of the European Ceramic Society, September 2005, Volume 26, Issue 13, pp 2785-2792 (abstract; table 2)	5-6
A	US 2001/0004470 A1 (HINTERMAIER et al.) 21 June 2001 (21.06.2001) paras [0008] and [0009]	1

☐ Further documents are listed in the continuation of Box C.

* 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 application or patent 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

"&" document member of the same patent family

Date of the actual completion of the international search

28 July 2009 (28.07.2009)

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 08/83599

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 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.: 7-10
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

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

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 additional fees, this Authority did not invite payment of additional fees.
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 and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.