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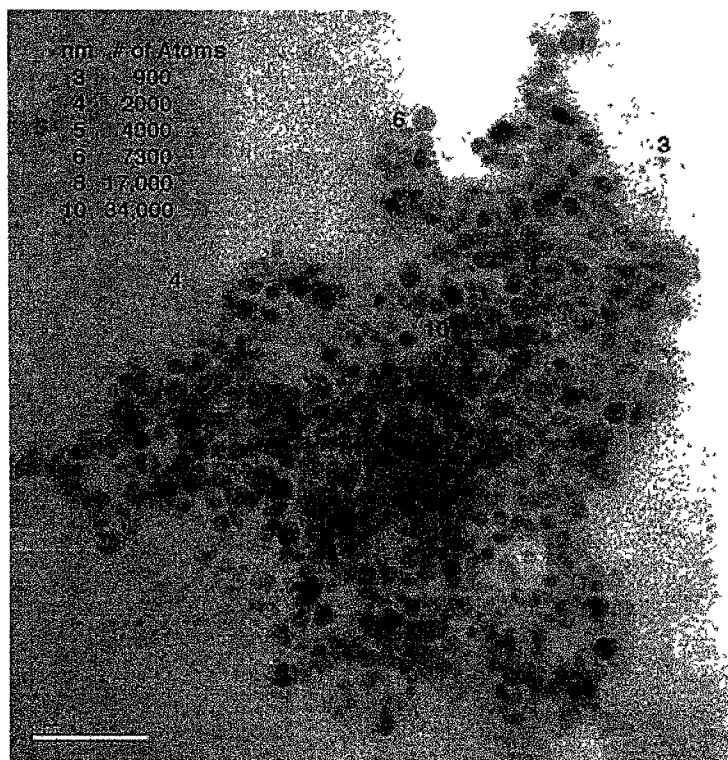
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[Continued on next page]

(54) Title: ELECTROCHEMICAL CATALYSTS



**Fig. 1**

(57) Abstract: A composition useful in electrodes provides higher power capability through the use of nanoparticle catalysts present in the composition. Nanoparticles of transition metals are preferred such as manganese, nickel, cobalt, iron, palladium, ruthenium, gold, silver, and lead, as well as alloys thereof, and respective oxides. These nanoparticle catalysts can substantially replace or eliminate platinum as a catalyst for certain electrochemical reactions. Electrodes, used as anodes, cathodes, or both, using such catalysts have applications relating to metal-air batteries, hydrogen fuel cells (PEMFCs), direct methanol fuel cells (DMFCs), direct oxidation fuel cells (DOFCs), and other air or oxygen breathing electrochemical systems as well as some liquid diffusion electrodes. Figure 1 is a transmission electron microscopy photograph of a nickel nanoparticle catalyst, illustrating size and uniformity of the particles.



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# INTERNATIONAL SEARCH REPORT

international application No

PCT/US2007/072996

A. CLASSIFICATION OF SUBJECT MATTER  
INV. H01M4/86 H01M4/90 H01M4/92 H01M8/10

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)  
HOIM

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

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2005/093881 A (TOHOKU TECHNO ARCH CO LTD [JP]; SHIMAZAKI YUZURU [JP]; (COBAYASHI YOSHI) 6 October 2005 (2005-10-06) abstract	1-50
X, P	-4 US 2007/026294 A1 (SHIMAZAKI YUZURU [JP] ET AL) 1 February 2007 (2007-02-01)  paragraph [0015] paragraph [0021] 'paragraph [0024] - paragraph [0026] paragraph [0046] - paragraph [0048] paragraph [0066] paragraph [0071] - paragraph [0072] paragraph [0088] paragraph [0090]  ----- V-	1-22, 27-30, 32-47

☒ Further documents are cited in the continuation of Box C.

☒ See patent family 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.

"&" document member of the same patent family

Date of the actual completion of the international search

26 June 2008

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17/07/2008

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# INTERNATIONAL SEARCH REPORT

International application No

PCT/US2007/072996

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with Indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2004/095603 A (CABOT CORP [US]; HAMPDEN-SMITH MARK J [US]; KODAS TOIVO T [US]; ATANAS) 4 November 2004 (2004-11-04) page 13, line 28 - line 29 page 20, line 29 - line 30 page 21, line 5 - line 7 page 21, line 19 - line 25 page 22, line 4 - line 5 page 23, line 23 - line 24 -----	1-22, 34-47
X <sub>1</sub> P	WO 2007/063615 A (JURIDICAL FOUNDATION OSAKA IND [JP]; UNIV OSAKA [JP]; IKEDA SHIGERU [J] 7 June 2007 (2007-06-07) abstract -----	1-22, 42-47
X,P	WO Z006/129413 A (MATSUSHITA ELECTRIC IND CO LTD [JP]; YAMADA YUKA [JP]; SUZUKI NOBUYASU) 7 December 2006 (2006-12-07) abstract -----	1-22, 42-47
A	EP 1 479 649 A (JAPAN SCIENCE & TECH AGENCY [JP]) 24 November 2004 (2004-11-24) -----	1-50

## FURTHER INFORMATION CONTINUED FROM PCT/ASA/ 210

Continuation of Box II.2

Claims 1\ios. : -

1. The present claims 1 and 34 relate to an extremely large number of possible products. Support and disclosure in the sense of Article 6 and 5 PCT is to be found however for only a very small proportion of the products and methods claimed, see description of the present application. The non-compliance with the substantive provisions is to such an extent, that the search was performed taking into consideration the non-compliance in determining the extent of the search (PCT Guidelines 9.19 and 9.23).

2. The search was restricted to those claimed products and methods which appear to be supported and a generalisation of their structural formulae, that is:

2.1. The search of claim 1 was restricted to a catalyst composition having metal nanoparticles and a substrate, said nanoparticles having an oxide shell.

2.2. The search of claim 34 was restricted to a catalyst composition having metal nanoparticles and a binder, said nanoparticles having an oxide shell.

3. The search of claims 17, 19, 22-24 and 27, comprising the product claimed in claim 1, and claims 42 and 47-49, comprising the product claimed in claim 34, was restricted in the same manner.

4. The search of the subject-matter of the dependent claims was also performed taking into account the above-mentioned restriction.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.2), should the problems which led to the Article 17(2)PCT declaration be overcome.

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US2007/072996

## 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:  
  
see FURTHER INFORMATION sheet PCT/ISA/210
  
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 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 allsearchable claims.
  
2. ☐ As all searchable claims could be searched without effort justifying an 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 the claims for which the required search fees were paid, specifically: Claims Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100.
  
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.

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2007/072996

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