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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

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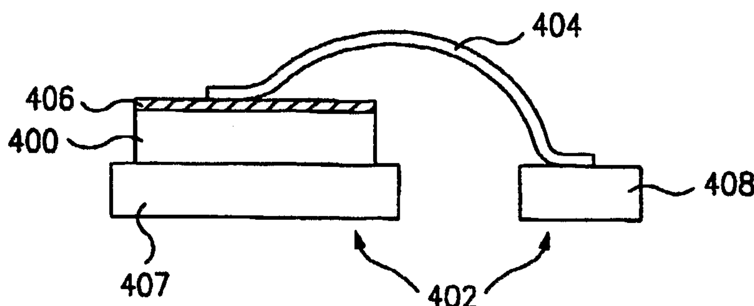
Declaration under Rule 4.17:
— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for all designations*

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

(88) Date of publication of the international search report: 23 February 2006

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: RIBBON BONDING



(57) Abstract: A flexible conductive ribbon is ultrasonically bonded to the surface of a die and terminals from a lead frame of a package. Multiple ribbons and/or multiple bonded areas provide various benefits, such as high current capability, reduced spreading resistance, reliable bonds due to large contact areas, lower cost and higher throughput due to less areas to bond and test.

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INTERNATIONAL SEARCH REPORT

International Application No
/US2004/013025

A. CLASSIFICATION OF SUBJECT MATTER
H01L23/36 H01L21/607 H01L23/66

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)
H01L B23K H01R

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	US 2002/163040 A1 (PAVIER MARK ET AL) 7 November 2002 (2002-11-07) paragraph '0002! paragraphs '0019! - '0021!; figure 1 paragraphs '0022!, '0023!; figures 2,2a paragraph '0026!; figure 4 ----- -/--	1-3,5,6, 13,17, 18,32, 33,35, 37,43,46

[X] Further documents are listed in the continuation of box C.

[X] 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

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"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	Date of mailing of the international search report
22 November 2005	16.01.2006

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Corchia, A

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CALATA J N ET AL: "Evaluation of interconnect technologies for power semiconductor devices" ITHERM 2002. EIGHTH INTERSOCIETY CONFERENCE ON THERMAL AND THERMOMECHANICAL PHENOMENA IN ELECTRONIC SYSTEMS (CAT. NO.02CH37258) IEEE PISCATAWAY, NJ, USA, 2002, pages 1089-1096, XP002355236 ISBN: 0-7803-7152-6 page 10891090, paragraph INTRODUCTION page 1090, paragraphs INTERCONNECT,TYPES-WIRE,BONDS page 1091, paragraphs SAMPLE,FABRICATION-MATERIALS - page 1092; figure 1 page 1093, paragraph WIRE BOND SAMPLE ASSEMBLY	1-6,17, 18, 22-27, 31-35, 43,46-48
X	EP 0 408 272 A (THE WELDING INSTITUTE) 16 January 1991 (1991-01-16) column 3, lines 41-48; figure 1 column 4, lines 30-42 column 5, lines 21-49; figure 3	1,2, 5-12,28, 32,39, 41,42
X	IVY WEI QIN ET AL: "Automatic wedge bonding with ribbon wire for high frequency applications" 27TH. IEEE/CPMT/SEMI INTERNATIONAL ELECTRONICS MANUFACTURING TECHNOLOGY SYMPOSIUM. (IEMT). SAN JOSE, CA, JULY 17 - 18, 2002, IEEE/CPMT INTERNATIONAL ELECTRONICS MANUFACTURING TECHNOLOGY (IEMT) SYMPOSIUM, NEW YORK, NY : IEEE, US, 17 July 2002 (2002-07-17), pages 97-104, XP010603400 ISBN: 0-7803-7301-4 the whole document	1,14-16, 32,37, 38,46,47
X	DE 42 32 745 A1 (TECHNISCHE UNIVERSITAET DRESDEN, 01069 DRESDEN, DE; TECHNISCHE UNIVERS) 31 March 1994 (1994-03-31) the whole document	1,7-12
A	US 5 097 100 A (JACKSON ET AL) 17 March 1992 (1992-03-17) column 3, lines 22-45 column 4, line 15 - column 5, line 16; figure 1 column 6, lines 12-38	1,7-12

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GEHMAN B L: "BONDING WIRE MICROELECTRONIC INTERCONNECTIONS" IEEE TRANSACTIONS ON COMPONENTS,HYBRIDS,AND MANUFACTURING TECHNOLOGY, IEEE INC. NEW YORK, US, vol. CHMT-3, no. 3, September 1980 (1980-09), pages 375-383, XP002059601 ISSN: 0148-6411 Section II. "Wire bonding technology - a brief overview"	24,31,47
A	IVY W.QIN, PAUL BEREZNYCKY, DAVE DOERR: "Wedge bonding for ultra fine pitch applications" ADVANCED PACKAGING TECHNOLOGIES SEMINAR, 2001, XP002355237 Semicon Singapore page 4 - page 5; figure 4	32,38
A	IVY W.QIN: "Wire Bonding: the Preferred Interconnect Method" CHIPSCALE REVIEW - INTERNATIONAL JOURNAL OF CHIP-SCALE ELECTRONICS, FLIP-CHIP TECHNOLOGY, OPTOELECTRONIC INTERCONNECTION AND WAFER-LEVEL PACKAGING, 'Online! 11 December 2002 (2002-12-11), XP002355238 Retrieved from the Internet: URL:http://www.chipscalereview.com> 'retrieved on 2005-11-11! the whole document	32,38
X	BENTON B: "RIBBON BONDING" ADVANCED PACKAGING, IHS PUBLISHING GROUP, US, vol. 8, no. 3, March 1999 (1999-03), pages 24-26, XP000803305 ISSN: 1065-0555 the whole document	1,4,22, 32,34, 46,48
A	US 5 646 450 A (LILES BARRY J ET AL) 8 July 1997 (1997-07-08) column 1, lines 33-55 column 2, line 60 - column 3, line 16; figure 1 column 4, line 13 - column 6, line 2; figures 2,3	4,26,27, 48
A	US 4 686 492 A (GRELLMANN H ERWIN ET AL) 11 August 1987 (1987-08-11) column 1, line 5 - column 2, line 37 column 3, line 1 - column 5, line 22; figures 1,2	20,21

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INTERNATIONAL SEARCH REPORT

International Application No
/US2004/013025

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	MARK KLOSSNER & STEVE BABINETZ: "Assembly solutions for 3-D stacked devices" PROCEEDINGS, SEMICON SINGAPORE 2002, 2002, pages A1-A10, XP002310158 "Introduction"; "Wire Bond Process Selection" Figs.10,11 -----	20,21

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2004/013025

Box 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.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box 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:

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: 1-6,17-27,29-35,43-48

   A ribbon interconnection for a device package characterised by the arrangement of the interconnections, namely the number of bonding pads, the number of parallel and overlying ribbons.

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2. claims: 1,7-12,14-16,22,28,32,39-42

   A ribbon interconnection for a device package characterised by the structure and materials of the bonding surfaces, namely the bonding pads and the multilayer ribbon.

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3. claims: 1,13,32,36-38

   A ribbon interconnection for a device package realised by means of a bonding tool characterised by the "foot" pattern and by the orientation of the bond.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
/US2004/013025

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
US 2002163040	A1	07-11-2002	NONE			
EP 0408272	A	16-01-1991	JP	3053536	A	07-03-1991
			US	5054680	A	08-10-1991
DE 4232745	A1	31-03-1994	NONE			
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			EP	0194133	A2	10-09-1986
			JP	61205001	A	11-09-1986