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(12) (B1)

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(21) 10 - 1999 - 0008580 (65) 1999 - 0082735  
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(30) 09/057,205 1998 04 08 (US)

(73)

10504

(72)

10520 - - 29

10598 816

10562 9 - 1

10514 36

10928 34

(74)

:

(54) 4

(low - temperature joining) C4 (flip - chip) (solder bump)  
C4  
(ball - limiting metallurgy) , Sn  
(patterning) (

copper - based) - (Sn - Pb) (eutectic) C4 .

1

1 C4 .

2 1 X Y .

3a 3h 1 .

10 : 12 :

14 : 16 :

18 : 20 :

(temperature - sensitive) (low -  
melting solder interconnection) , SnPb (eutectic)  
(ball - limiting metallurgy : BLM)

C4(controlled - collapse chip connection) IC(integrated circuit)  
, C4 (flip - chip) ,  
(area array) , C4 가

C4 1960 IBM , , P  
bSn . 1990 , C4  
( , (M. Datta, et al.) Electrochemical Fabrication of Mechanically Robust P  
bSn Interconnections, J. Electrochem. Soc., 142 142, 3779 (1995), (Yung) 5,162,257 , W  
O 96/30933 ). C4 , ,  
( Sn ) .

/ . C4  
(under - bump metallurgy : UBM)

(reflow) (adhesion) (wetting) 가

(MCM(multi - layer ceramic module)) , Pb

C4 (joint) . Pb 300

Cr . Pb TiW( ), CrCu, Cu 5 % (thin film stack) . Sn Cu

(intermetallic) . 5 % Sn (terminal layer)

, Cu ( , 0.5  $\mu$ m)

300 (laminate)) (direct chip attach : DCA)

63 % Sn SnPb

Cu Sn Cu , Cu/Sn (S. K. Kang, et al.)

Interfacial Reactions During Soldering with Lead - Tin Eutectic and Lead (Pb) - Free, Tin - Rich Solders, J. Electronic Mater., 25, 1113 (1996) ).

SnPb 97Pb3Sn 100 , 0.5  $\mu$ m Cu 가

. Cu 가 0 603 296 B Cu - Sn , MCM , Cu가

BLM (thermal cycling) (chip - side) (barrier layer : BL)

Sn

Cu SnPb . Ni/Sn Cu가 ( Cu/Sn

Sn , C4 가 Cu .

(stand - off) C4 SnPb

MCM , C4 Pb , Pb

가 . SnPb , SnPb Sn, C4 , Pb

Pb (Dalal, et al.)

5,634,268 , (Gall, et al.) 5,391,514 , (J. D. Mis, et al.) Flip Chip Production Experience: Some Design, Process, Reliability, and Cost Considerations, Proc. 1996 Intern

ational Symposium on Microelectronics, SPIE Vol. 2920, p. 291 ).

, Pb (pedestal), Sn, Cu

, Sn, Pb, Sn ( (Greer) C4 (through - mask) 5,470,787 ), Sn, Sn, Cu가, Sn, Pb, Sn

가 Sn ( NiP ( screening), (injection molding), (stencil printing), Au ) (mechanical bumping) C4 ( J. Audet, et al.) Low Cost Bumping Process For Flip Chip, Proc. 1995 International Flip Chip, BGA, and Advanced Packaging Symposium, p. 16, (E. Jung, et al.) The Influence of NiSn Intermetallics on the Performance of Flip Chip Contacts using a Low Cost Electroless Nickel Bumping Approach, Proc. 1996 Electronics Packaging Conference, IEPS, p. 14 ). NiP Al(Cu) 가, 가, 가, NiP, NiP, C4

C4 Sn

, Sn SnPb, Sn SnPb Sn C4

(pad pitch) C4 (patterning) C4

가 (undercut), 가 (wicking) C4

(circuit board) (heat - sensitive)

C4

SnPb C4 /

(passivation) (blanket) —

(opening) — ,

,

,

,

,

C4 ,

,

C4

,

C4

C4 SnPb

가

가

M BLM 가 . BLM Cu가 가 BLM BL

BLM 가

1 ,

1 (12)가 (10) (12) (

10) (14) (16) (14) . (18) (20) (12) (16)

Si, Ge, SiGe, GaAs, GaP, InAs, InP

Si (active) (IC)

IC

IC Cu, Al, Cu Cu Al

(12) Al

e) (14) (polyimide), (silicon dioxide) (silicon nitride)  
 (14) (12)  
 (14) (12)  
 BLM (14) (12)  
 (12) BLM(16) 1  
 2 가 ( ) 1  
 BLM(16)  
 2 1 X - Y , BLM(16)  
 , BLM(16) 1 (16a), 2 (16b), 가 (16c)  
 (12) (14) 1  
 , 1 (16a) IC  
 . 1 (16a) (12) (14)  
 . 1 (16a) Ti, W, Cr  
 , 1 (16a) TiW  
 2 (16b) 가  
 Cr , 가 (16c) 2 Cu 1 (16a)  
 (phased) CrCu  
 BLM(16) , (mechanical strength), (contact resistance)  
 sistance) 가 (16c) Cu, Ni, Co, Au, Fe  
 , 가 (16c) Cu  
 가 (16c) (20) Sn , 가  
 (16c) (18) Ni NiFe, Fe, Co  
 , (18) Ni  
 1 2 C4 , 2 (16b) 가 (16c)  
 C4 3a 3h ,  
 C4  
 , 3a (10)  
 ( ), (12), (12) (10)  
 (14) 3a  
 1 가 3b , 3b BLM  
 (16)  
 (16b), 가 (16c) , BLM(16)  
 BLM(16) ( 1 (16a), 2  
 ) TiW

, ( 2 ) CrCu , 가 Cu .

BLM(16) (12) (14)  
 : CVD), (chemical vapor deposition),  
 (plasma enhanced vapor deposition),  
 . BLM BLM(16) , BLM(16)  
 . 가 , BLM  
 (14) .

50 nm , BLM(16) (nucleation)  
 (capping) .  
 Au Cu 가 .  
 , 3c , (22) (12) BLM(16)  
 , C4 (standard photolithographic)

(dry - film) (liquid)  
 , 가 (18) ,

(22) (18) 3d  
 Ni , Ni  
 Ni (18) . Ni<sup>2+</sup> (chloride salt),  
 (sulfate salt) (sulfamate salt) .  
 oric acid buffer), 2 5 pH, 0.1 1.5 mole/l Ni<sup>2+</sup> , 0 0.8 mole/l (b  
 20 70 , 5 30 mA/cm<sup>2</sup>

, (anode depolarizer) Ni (wetting agent)  
 (stress reliever) (agent) .

0.2 5.0  $\mu$ m

, Au, Cu, Sn  
 (18) (exchange deposition) .

(18) , Sn, Pb, (20a) (22)  
 ( 3e ). SnPb . ,  
 63 % Sn 37 % Pb PbSn (20a) 100  $\mu$ m

, SnPb Sn<sup>2+</sup> Pb<sup>2+</sup> (methane sulfonic acid) .  
 , 가 ,  
 1 Sn<sup>2+</sup> 0.1 0.3 mole/l, Pb<sup>2+</sup> 0.04 0.2 mole/l,  
 2.5 mole/l , 20 100 mA/cm<sup>2</sup> .

(dense) (compact) 가 C4 가 (organic addition agent)가 가

SnPb .

3f , (20a) BLM(16) , (18) , 3g

BLM(16) , CrCu Cu , TiW

K<sub>2</sub>SO<sub>4</sub> 0.4 mole/l (glycerol) 1.5 mole/l (

5,486,282 , 5,462,

TiW 60 H<sub>2</sub>O<sub>2</sub>, EDTA, K<sub>2</sub>SO<sub>4</sub> ). Ni

638 , (18) (16a, 16b 16c)

BLM ,

3h , (20a) (20)

(dicing)

가 C4 , Sn SnPb C4

가 C4 , 가

C4

(57)

1.

C4, —  
(passivation) (blanket)



C4

,

,

C4

,

,

C4

C4

.

2.

1

,

1

(wetting) 가

C4

.

3.

2

,

1

가

2

C

4

.

4.

2

,

1

Ti, W, Cr,

C4

.

5.

4

,

1

TiW

C4

.

6.

2

,

가

Cu, Ni, Fe, Au,

C4

.

7.

6

,

가

Cu

C4

.

8.

3 ,

2 CrCu C4 .

9.

1 ,

Ni, Co, Fe, C4

10.

9 ,

Ni C4 .

11.

9 ,

NiFe C4 .

12.

1 ,

C4 가 Sn, Pb, C4 .

13.

12 ,

C4 가 (eutectic) Sn Pb C4 .

14.

2 ,

C4 가 가 .

15.

3 ,

C4 가 가 2 .

16.

15 ,

가 2 가  
C4 .

17.

2 ,

가 1 C4

.

18.

1 ,

C4 (reflow) C4 .

19.

,

(opening)

,

(undercut ball I

imiting metallurgy) ,

,

.

20.

19 ,

.

21.

20 ,

1 , 2 , 가 .

22.

21 ,

1 Ti, W, Cr

23.

21 ,

가 Cu, Ni, Co, Fe, Au

24.

21 ,

2 CrCu

25.

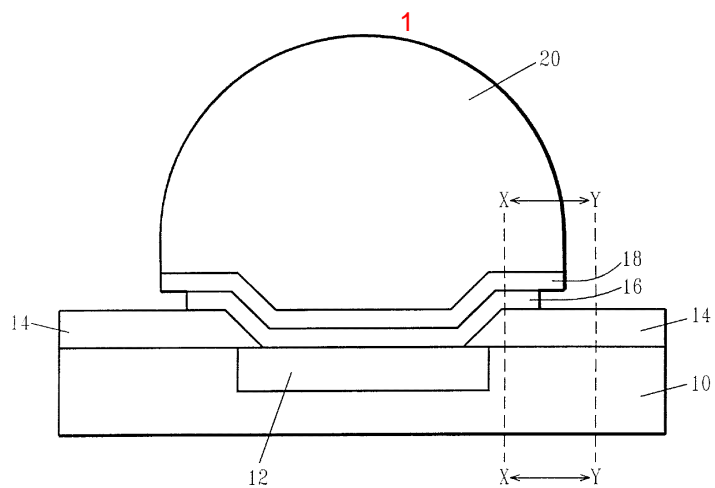
19 ,

Ni, Co, Fe

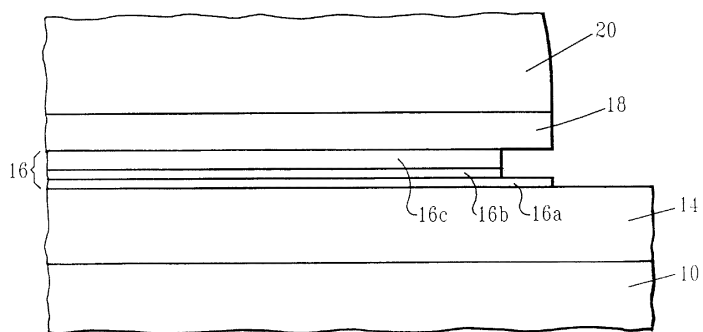
26.

19 ,

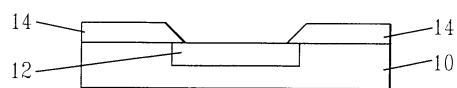
Sn, Pb



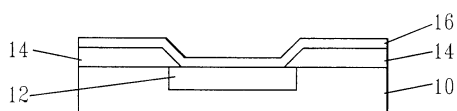
2



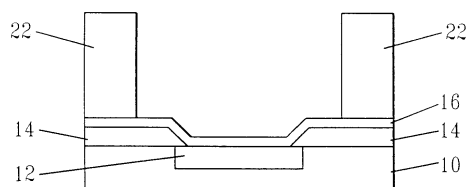
3a



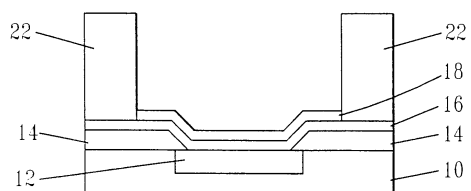
3b



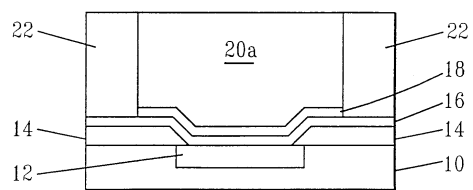
3c



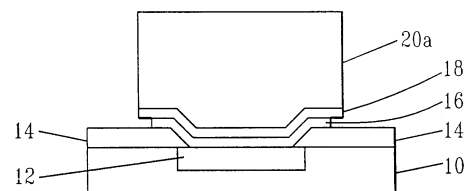
3d



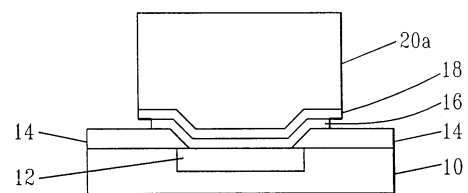
3e



3f



3g



3h

