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Table 1. The properties of polymer material obtained from the manufacturer

Properties		NCA 1	NCA 2
Matrix		Epoxy	Epoxy
Nonconductive fillers		Yes	Yes
Viscosity (Pas)		100	65
CTE (10^{-6}/℃)	α_1	65	50
	α_2	195	80
T_g (℃)		72	55

NCA (Non-Conductive Adhesive)
COG

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한양대학교 신소재공학과

Failure in the COG Joint Using Non-Conductive Adhesive and Polymer Bumps

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□ □: □ □□□□□ Non-Conductive Adhesive (NCA) □ □□□ □□□ □□□ COG (Chip-on-glass) □□□ □□□ □□□□□. □□□□ □□□ Si □□ □□ □□□ □□□ □□□□ □□□□ □□□□, □□□ □□ □□ □□ □□□□□ □□□□ □□□□ □□ □□□□ □□□□□. □□□□□ Al □ □□□ □□□□□ □□□□□. □ □□□ NCA □ □□□□ 80℃ □□ □□□ □□□□□□ □□□ □□□□□. □□□□ □□□ □□□□ □□□ 4□□ □□ □□□□ □□□□ □□□□ □□ □□□ □□□□□□, □□□□□□□□ □□□□ □□□□ □□□□□. □□□□ 0℃ □ 55℃ □□□□ □□□ □□□ 2000□□□ □□□□ □□□□□. □□□ □□ □ □□□□ □□ □□ 70-90 mΩ □ □□□□□. 200 MPa □□□ □□ □□□□□ □□□ □□□ NCA □ □□ □□□□ □□

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Abstract: We studied a bonding at low temperature using polymer bump and Non-Conductive Adhesive (NCA), and studied the reliability of the polymer bump/Al pad joints. The polymer bumps were formed on oxidized Si substrates by photolithography process, and the thin film metals were formed on the polymer bumps using DC magnetron sputtering. The substrate used was Al metallized glass. The polymer bump and Al metallized glass substrates were joined together at 80°C under various pressure. Two NCAs were applied during joining. Thermal cycling test (0°C-55°C, cycle/30 min) was carried out up to 2000 cycles to evaluate the reliability of the joints. The bondability was evaluated by measuring the contact resistance of the joints through the four point probe method, and the joints were observed by Scanning Electron Microscope (SEM). The contact resistance of the joints was 70-90 mΩ before the reliability test. The joints of the polymer bump/Al pad were damaged by NCA filler particles under pressure above 200 MPa. After reliability test, some joints were electrically failed since thinner metal layers deposited at the edge of bumps were disconnected.

Key words: polymer bump, NCA, flip chip bonding, reliability test

1. 서 론

현재 LCD 구동회로 실장에 Anisotropic conduc-tive film (ACF)을 이용한 방법이 널리 적용되고 있다. 이 방법은 고분자 기지에 Au, Ni 등의 금속 입자 또는 Au, Au/Ni 을 코팅한 플라스틱 입자와 같은 전도 입자가 들어있는 이방성 전도 필름을 IC 칩과 LCD 패널 사이에 넣고 열압착시켜 IC 칩을 LCD 패널에 실장 시키는 방법이다. 현재 전도 입자로는Au/Ni 을 코팅한 플라스틱 입자를 많이 사용하고 있는데, 이는 접합 시 범프의 높이 편차를 전도 입자의 변형으로 보정해 줄 수 있을 뿐 아니라 접합 후 전도 입자의 탄성 변형에 의한 접합부의 신뢰성을 향상시킬 수 있다. 그러나 내부 전도성 입자에 의해 범프와 패드가 연결되므로 범프 면적에 비해 접합 면적이 상대적으로 작아 높은 접속 저항을 가질 뿐 아니라 미세피치로의 적용에 있어 접합부의 open 현상과 단락현상이 발생할 수 있다.[1-5] 따라서 디스플레이 분야에 적용 가능한 새로운 저온 접합 공정 개발이 요구되고 있고, 실용화에 적합한 높은 신뢰성을 갖는 접합 또한 필요하다.[6] 이러한 저온 접합이 가능하고, 높은 신뢰성을 갖는 접합 방법 중 고분자 범프를 이용한 접합 방법이 연구되었다.[7-17] 일반적으로 금속 범프의 열팽창계수는 접착제에 비해 상당히 낮기 때문에 온도가 변화함에 따라 범프보다 접착제의 팽창 및 수축이 더 커서 접합부에 큰 스트레스를 가하여 open circuit을 유발할 수 있다.[15] 그러나 고분자 범프를 사용할 경우 고분자의 탄성계수가 작으므로 낮은 압력 하에서 접합이 가능하며, 접합 후 고분자의 탄성력에 의해 기판과 패드 사이를 분리시키는 응력을 완화시켜주기 때문에 물리적, 전기적으로 신뢰성 있는 접합을 가능하게 해준다.[17] 또한 고분자 범프는 범프 형상과 높이의 제어가 용이하고, 제조 공정이 간단하여 시간과 비용을 절약할 수 있다는 장점이 있다.[10] 기존에

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7-10)

11), 12-17) .

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Non-conductive adhesive (NCA) Z

.[15]

NCA .

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. , NCA

(SEM) .

2.

Si

, Au

(0.05 μm)/Cu (1 μm)/Ti (0.05 μm) , Al (1 μm)

. Table 1

. Fig. 1 Si Al

, NCA 80°C

360 .

NCA . 0°C 15 , 55°C

15 1 2000 , NCA 1 NCA 2 T_g

Table 1 72°C, 55°C . Aglient 433B

milliohm meter 4 ,

20% failure . JEOL

SEM .

3.

Si Al

. NCA Si

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Fig. 2 ,
Au/Cu/Ti . Fig. 2(a) Fig. 2 (b)
Fig. 2(c)
.
,
[11]
.

Fig. 3 SEM . 100 MPa
NCA filler (Fig.
3(a)). Fig. 3(b) Fig. 3(c) 150 MPa Al
Fig. 3(d), (e) 200 MPa
.
.
200 MPa
( ) .
.

NCA 150 MPa /Al
Table 2 . NCA 1
75 mΩ, NCA 2 80 mΩ
.

150 MPa Fig. 4
, failure rate Fig. 5 . Fig. 4 2000
fail , failure rate
NCA (Fig. 5). NCA 1
500 3% failure rate 2000 , NCA 2
100 5% failure rate
2000 2000 26% failure rate
. fail 2000
Fig. 6 . fail NCA
fail
NCA Z
, . 50 10^{-6}/°C
NCA NCA .

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NCA 2 NCA 1 failure rate

55℃ NCA 2 NCA 2 ,

NCA 1

.

55℃ 72℃ .

4.

NCA COG .

Al ,

NCA . NCA

.

1. ,

Au/Cu/Ti .

,

2. Al NCA 80℃

, 200 MPa

.

NCA 150 MPa NCA 1,

NCA 2 75 mΩ, 80 mΩ .

3. 2000 NCA failure rate ,

NCA 1 2000 3% failure rate

NCA 2 100 failure rate

2000 26% failure rate .

4. Fail NCA

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NCA ,

fail .

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1. R. Joshi, “Chip on glass--interconnect for row/column driver packaging”, Microelectronics Journal, Vol.29, No.6, 343-349 (1998)
2. M. -J. Yim and K. -W. Paik, “Design and understanding of anisotropic conductive films (ACF's) for LCD packaging”, IEEE Tran. Comp. Packag. Manufact. Technol., Part A, Vol. 21, No. 2, 226-234 (1998)
3. J. Liu, Z. Lai, H. Kristiansen, and C. Khoo, “Overview of conductive adhesive joining technology in electronics packaging applications”, Adhesive Joining and Coating Technol. in Electron. Manufact., Proc. of 3rd Inter. Conf., 1-18 (1998)
4. F. G. Shi, M. Abdullah, S. Chungpaiboonpatana, K. Okuyama, C. Davidson, and J. M. Adams, “Electrical conduction of anisotropic conductive adhesives: effect of size distribution of conducting filler particles”, Mater. Sci. in Semiconductor Processing, Vol.2, No.3, 263-269 (1999)
5. Y. -T. Hsieh, “Reliability and failure mode of chip-on-flim with non-conductive adhesive”, Electron. Mater. Packag., Proc. of the 4th Inter. Symp., 157-160 (2002)
6. M. Takeichi and M. Nagashima, “Trend of solder-less Joint in Flip Chip Bonding”, Polymers and Adhesives in Microelectronics and Photonics, First Inter. IEEE Conf., 168-172 (2001)
7. R. H. Estes, “Flip-chip packaging with polymer bumps”, Semiconductor inter., Vol. 20, No.2, 103-108 (1997)
8. K. W. Oh and C. H. Ahn, “A new flip-chip bonding technique using micromachined conductive polymer bumps”, IEEE Tran. Adv. Packag., Vol. 22, No.4, 586-591 (1999)
9. C. K. Y. Wong, O. C. T. Cheung, B. Xu, and M. M. F. Yuen, “Using PDMS microtransfer molding (μTM) for polymer flip chip”, Electron. Comp. Technol. Conf., Proc. 53rd, 652-657 (2003)
10. D. W. Prather and S. Lohokare, U.S Patent, 7,109, 107, 9 (2006)
11. G.. Norberg, S. Dejanovic, and H. Hesselbom, “Very High Density Interconnect Elastomer Chip Sockets”, IEEE Tran. Adv. Packag., Vol. 29, No.2, 202-210 (2006)
12. W. -Y. Zhang, J. P. Labukas, S. Tatic-Lucic, L. Larson, T. Bannuru, R. P. Vinci, and G. Ferguson, “Novel room temperature first level packaging process for microscale devices”, Sensors and actuators. A, Phys., Vol. 123/124, 646-654 (2005)
13. C. -T. Pan, H. Yang, S. -C. Shen, M. -C. Chou, and H. -P. Chou, “A low-temperature wafer bonding technique using patternable materials”, J. micromechanics and microengineering, Vol. 12, No.5, 611-615 (2002)
14. W. -Y. Zhang, G. S. Ferguson, and S. Tatic-Lucic, “Elastomer-supported cold welding for room temperature wafer-level bonding”, Micro Electro Mechanical Systems, 17th IEEE Inter. Conf. (MEMS), 741-744 (2004)
15. K. Keswick, R. L. German, M. Breen, and R. Nolan, “Compliant bumps for adhesive flip-chip assembly”, IEEE Tran. Comp. Packag. Manufact. Technol. Publication of the IEEE Comp., Packag. Manufact. Technol. Society and the IEEE Lasers and Electro-Optics S, Vol. 18, No.3, 503-510 (1995)
16. H. -C. Cheng, C. -L. Ho, K. -N. Chiang, and S. -M. Chang, “Process-dependent contact characteristics of NCA assemblies”, IEEE Tran. Comp. Packag. Ttechnol., Vol. 27, No. 2, 398-410 (2004)
17. S. -M. Chang, Y. -C. Lee, H. -M. Yu, L. -H. Yang, and J. -H. Jou, U.S Patent, 5,393,697,2 (1995)

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Table 2. The average contact resistance and standard deviation before thermal cycling test

NCA	NCA 1		NCA 2	
	Contact resistance	Standard deviation	Contact resistance	Standard deviation
Metallized polymer bump/Al pad	75.8 mΩ	29.2	80.9 mΩ	37.6

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