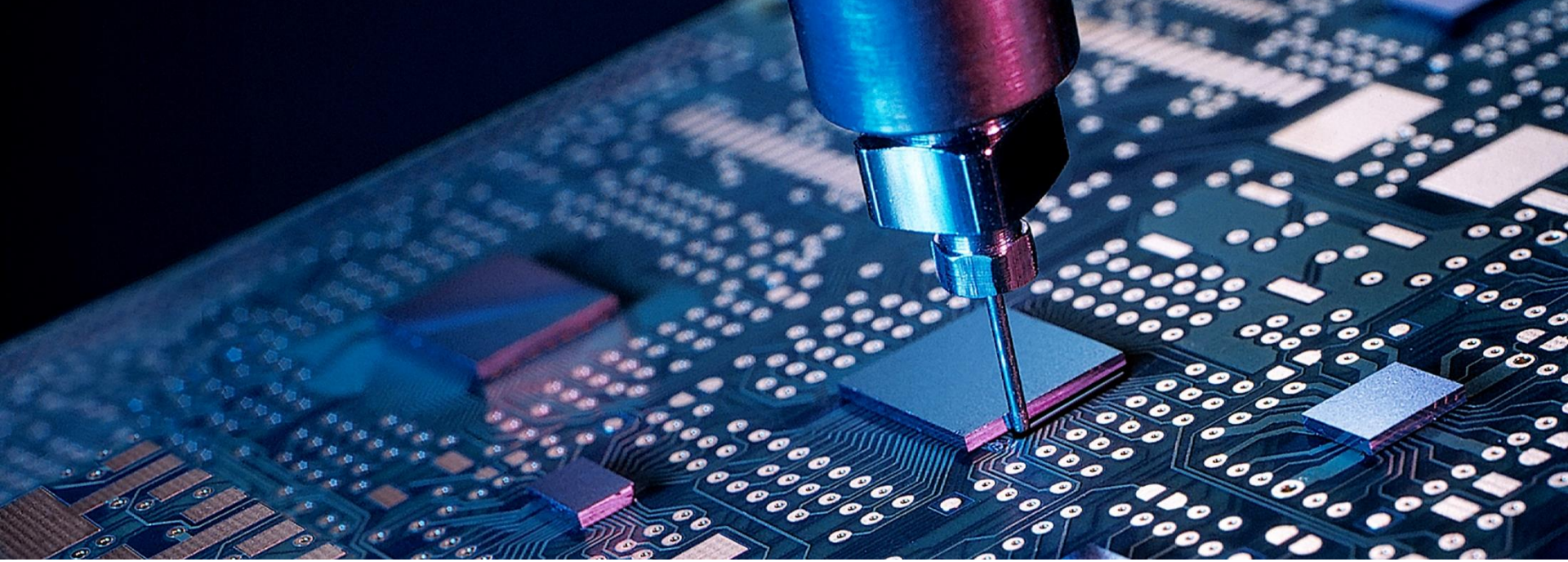




HENKEL UNDERFILL底填胶和ENCAP包封胶 解决方案简介

JETT PAN 20230609

Henkel

日程

- 为什么需要Underfill底填胶
- 汉高Underfill产品家族
- 为什么需要Encap包封胶
- Encap产品家族
- 材料关键参数及可靠性评估



汉高电子组装保护材料方案

- 低压注塑LPM:

- ✓ 部件包封，效率高，绿色环保；聚酰胺热熔胶

- 共形覆膜 Conformal coating:

- ✓ PCB板保护，薄涂层；聚氨酯，丙烯酸，有机硅体系

- 灌密封胶 Potting:

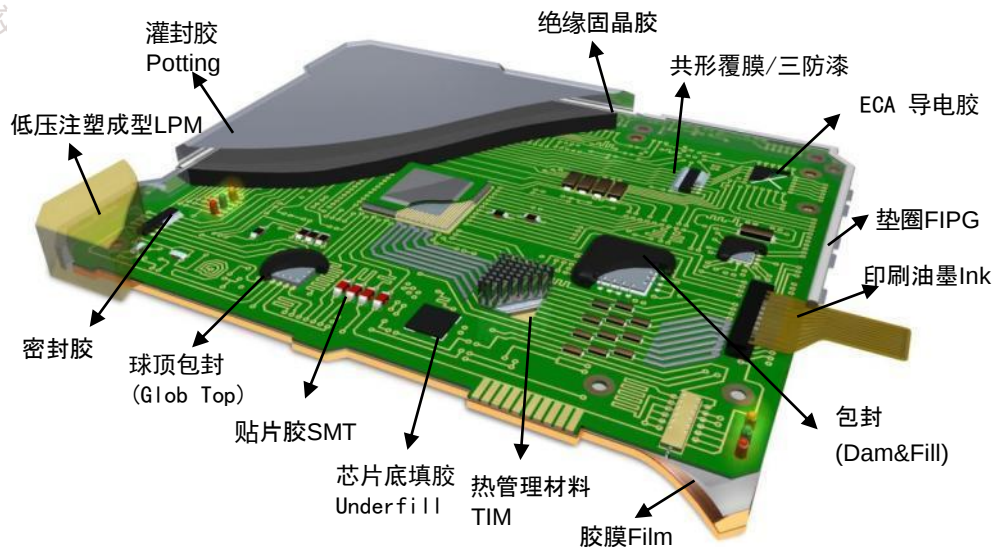
- ✓ 需要外壳，填充；环氧，聚氨酯，有机硅

- 芯片底部填充胶 Underfill:

- ✓ 芯片焊点保护；环氧，丙烯酸

- 元器件包封胶 Encap:

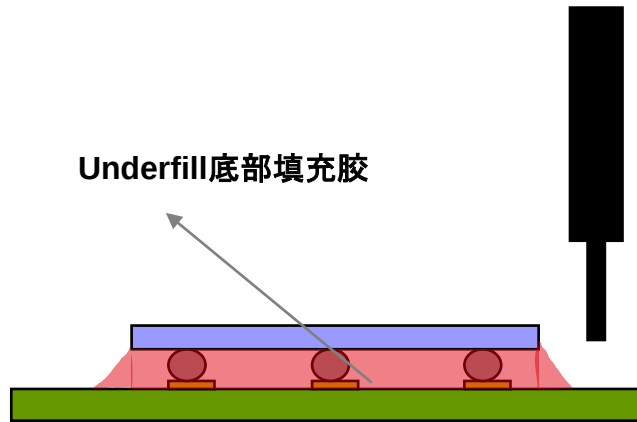
- ✓ 小型器件包封保护；环氧，丙烯酸体系



汉高底部填充胶UNDERFILL方案

定义

- 底部填充胶是热固型环氧体系胶水，可以通过毛细作用力流到芯片底部。
- 底部填充胶是应用在锡膏回流焊之后，需要热固化的材料。
- 底部填充胶粘度很低，可以通过毛细作用力流到元器件底部。
- 有时基板需要加热以保证胶水良好的流动性。
- 底部填充胶用于提高焊球的可靠性。



汉高底部填充胶UNDERFILL方案

价值

1 焊点保护

2 热稳定性

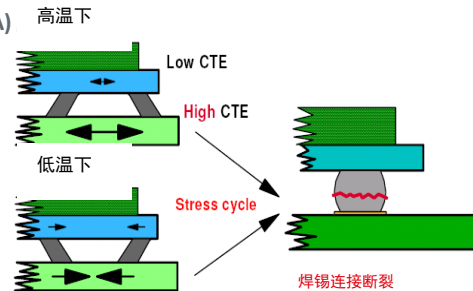
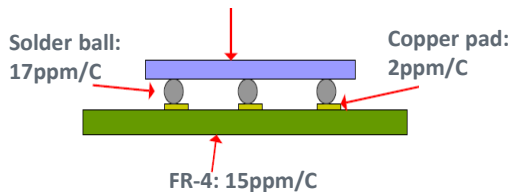
3 抗跌落

4 抗震动

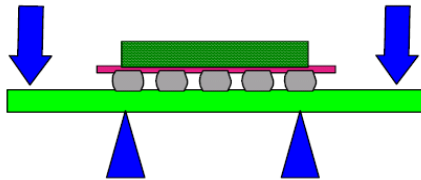
5 防湿气

I. 热应力

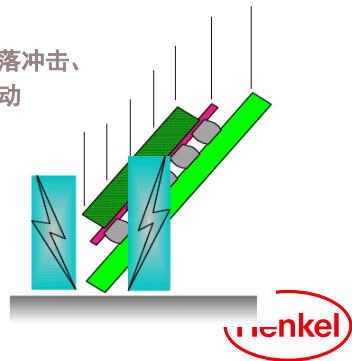
Moulding compound: 10-20ppm/C (for CSP/BGA)
chip: 2ppm/dC (for flip chip/WL-CSP)



II. 机械应力 (弯曲、翘曲)

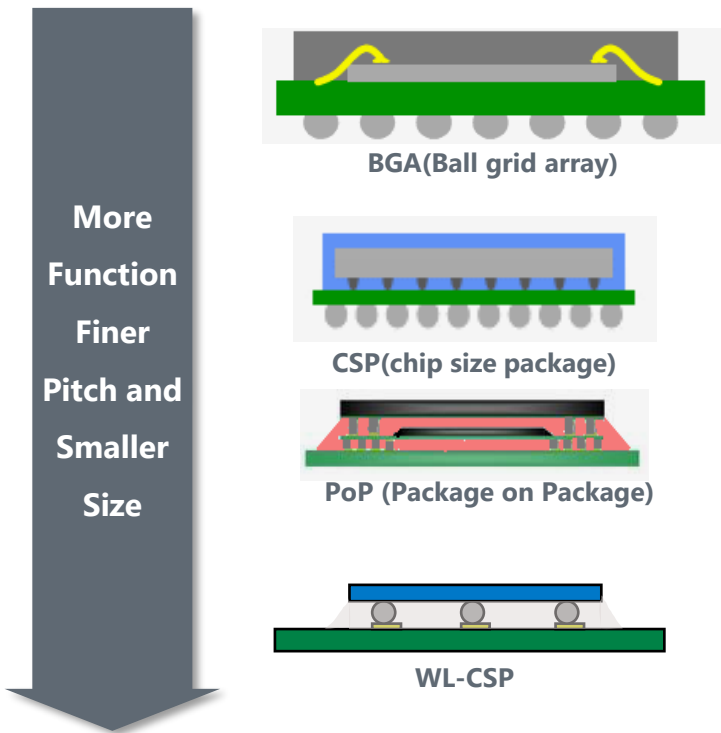


III. 跌落冲击、 III. 振动



UNDERFILL底填胶技术发展

封装方式的变迁驱动材料发展



BGA:

- Mechanical Reinforcement
- Flexible & Unfilled
- Full UF not always required
- Less TC Improvement required

CSP & PoP:

- Mechanical reinforcement
- Flexible
- Thermal cycling improvement

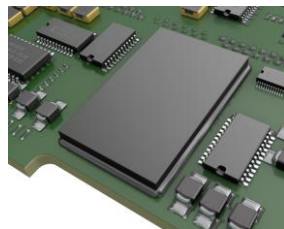
WLCSP:

- Thermal cycling reinforcement
- Mechanical reinforcement
- Similarity to package level Underfill

汉高底部填充胶UNDERFILL应用



可靠性、返修、UPH平衡



高可靠性，返修



高可靠性

6/21/2023

汉高底部填充胶UNDERFILL

不同应用

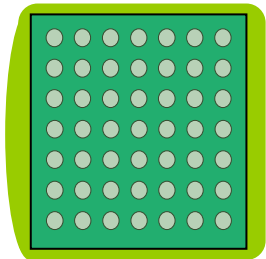
	消费电子	工业电子	汽车电子
芯片尺寸	小-中	小-大	小-中
应用点	机械冲击（跌落，弯曲）， 隔离湿气等	冷热冲击，高温，高湿等 严苛使用环境下的可靠性	冷热冲击，高温，高湿， 震动等环境下的可靠性
可靠性要求	较低 -40-85C, 65/95*168h SIR, 跌落	中等 -40-125C, 8585*1000h SIR	高 -50-150C, 8585*1000h SIR
返修性	中-高	中-高	低-中

汉高底部填充胶UNDERFILL

技术分类

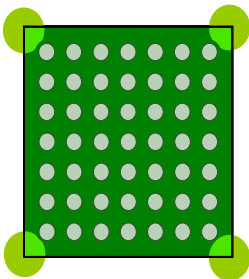
全底填-毛细吸附底填 (CUF)

- 回流焊后点胶
- 流动性好，底部全填充
- 只有热固型产品
- 最佳的可靠性提升
- 板级和封装级产品可选



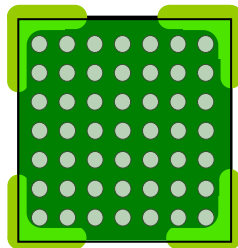
部分填充-Corner-bond

- 回流焊前点胶
- 四个顶角点胶
- 只有热固型（回流焊过程中固化）
- 有限的可靠性提升



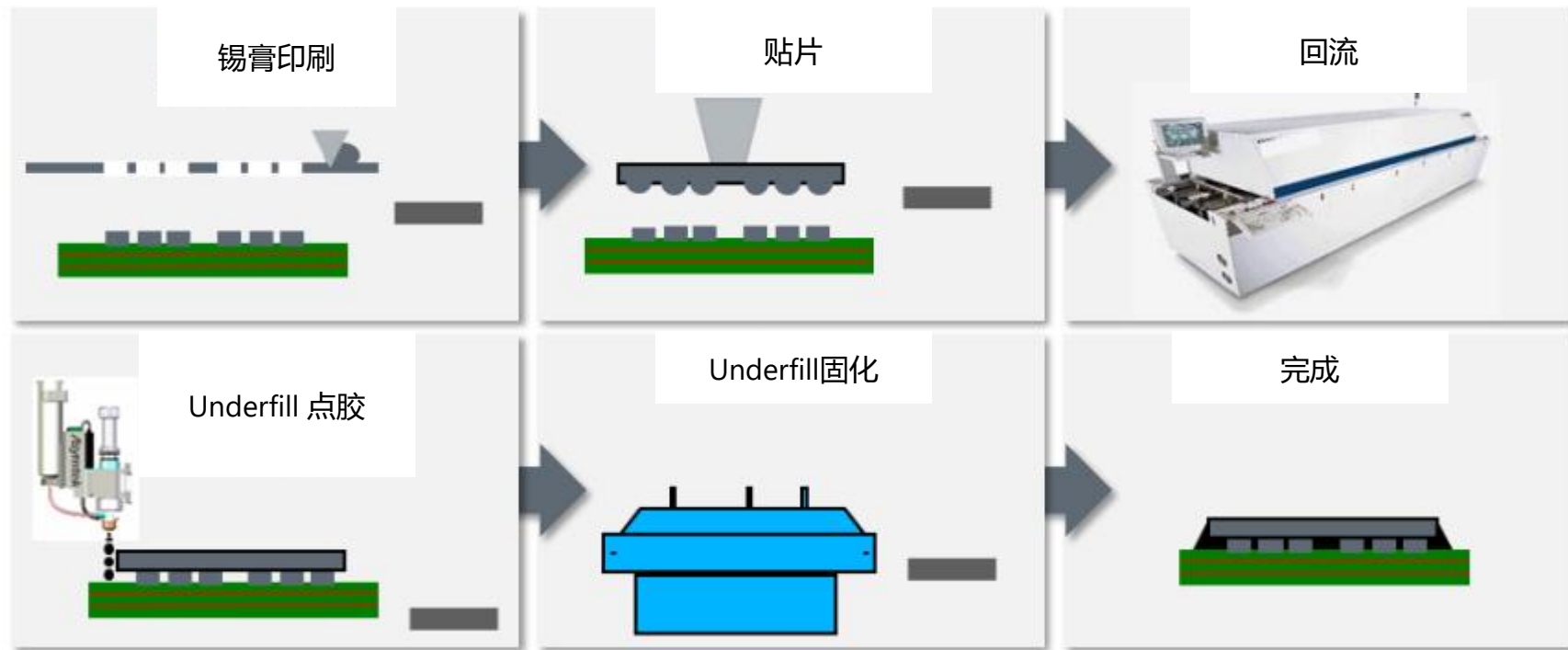
部分填充-Edge-bond

- 回流焊前点胶
- 四个边角点胶
- 固化方式热固/uv/湿气或组合固化
- 中等的可靠性提升



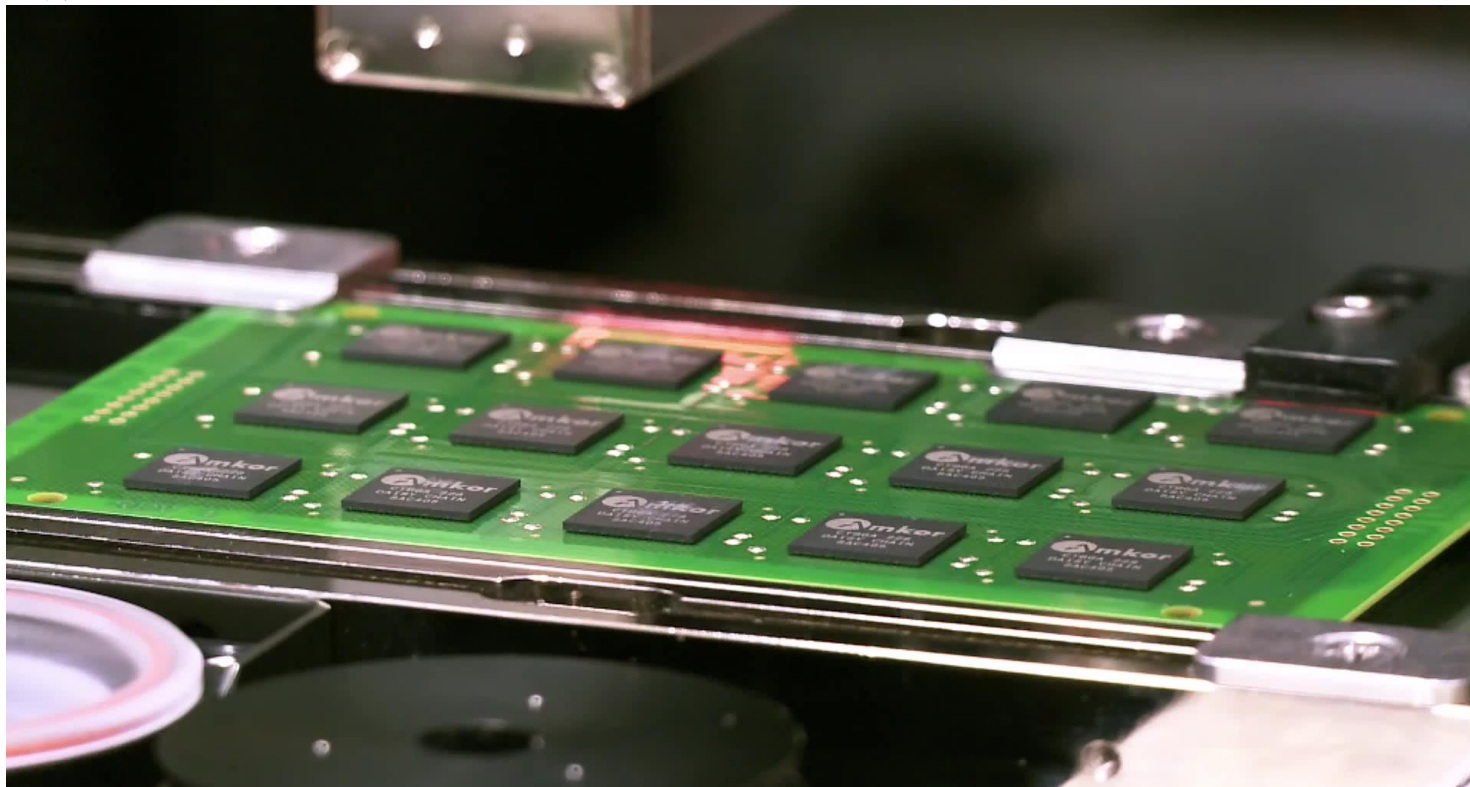
汉高底部填充胶UNDERFILL

应用工艺---全底填&EDGE-BOND



汉高底部填充胶UNDERFILL

点胶



汉高底部填充胶UNDERFILL

点胶注意事项

- 基板的清洁（溶剂、等离子...）可以增加基板的表面张力，增加underfill对基板的润湿和固化后的粘接力
- 点胶基板预烘烤（去除水分和溶剂）
 - 刚过完Reflow后不需要
 - 过完reflow后，基板放了一段时间可能会吸潮，建议烘烤
 - 湿气可能会导致underfill固化过程中产生孔隙
 - 高可靠性underfill具有较高的粘度，加热基板（典型值60-100°C）可以促进underfill流动和对基板的浸润
- 高粘度underfill除了对基板进行加热，点胶阀也需要加热（典型值40-60°C）
- 不同的基板和不同的处理方式会导致underfill不同的流动和对基板的浸润表现

汉高底部填充胶UNDERFILL 点胶PATTERN

Small Chip
<5mmX5mm



Corner dot



Center dot

Middle Chip
<10mmX10mm

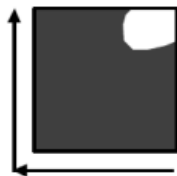


100% I-line

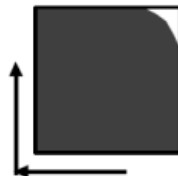


60% I-line

Large Chip
>10mmX10mm



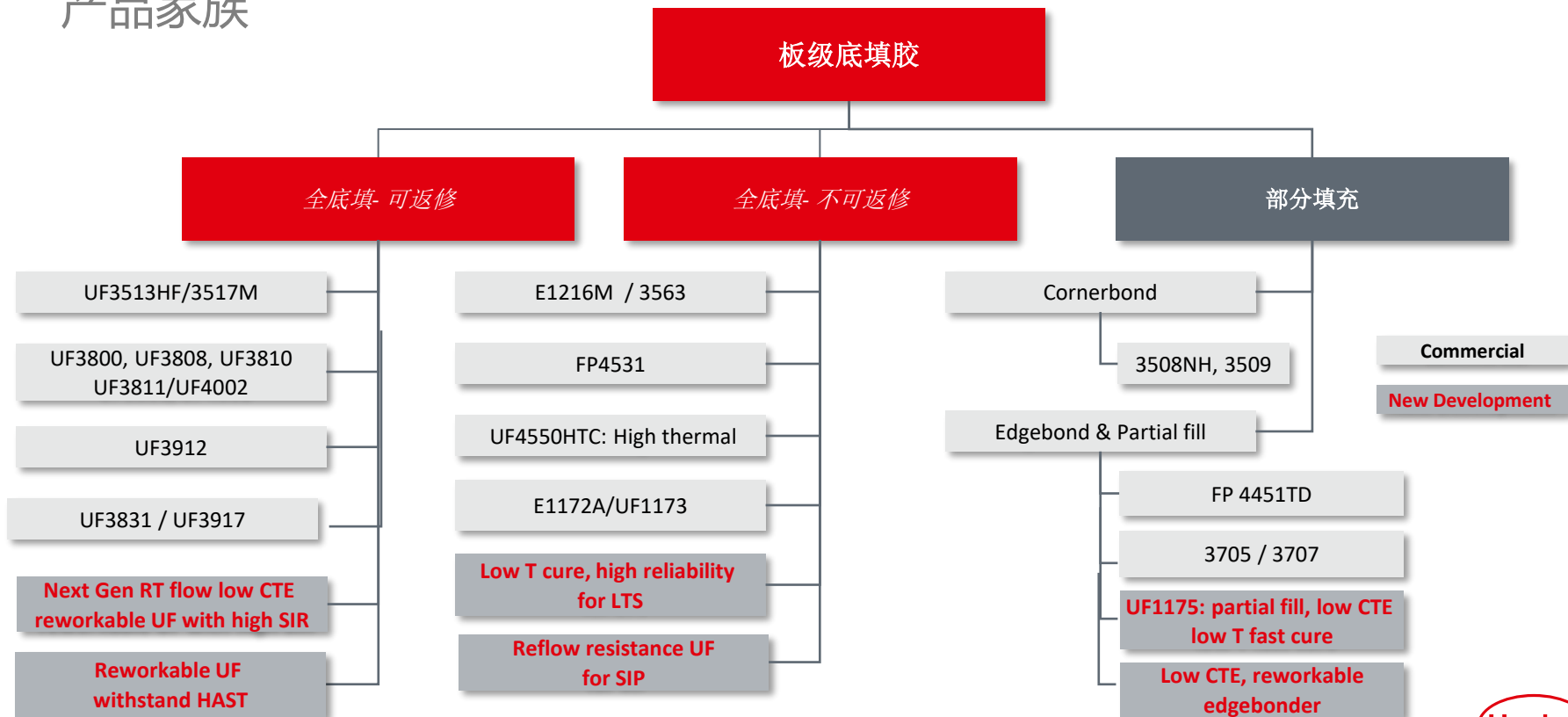
100% L-line



65% L-line

汉高底部填充胶UNDERFILL

产品家族



汉高底部填充胶UNDERFILL

产品家族---可返修全底填

Item	UF3810	UF3808	UF3917	UF3811	UF3812	UF4002	UF3831	UF3927
Chemistry	Epoxy/ Amine	Epoxy/ Amine	Epoxy/ Amine	Epoxy/ Anhydride	Epoxy/ Anhydride	Epoxy/ Anhydride	Epoxy/ Anhydride	Epoxy/ Anhydride
Description	Good Rework	Good TC	2-in-1 with high TC/SIR	Good rework	Rework/TC balance	Rework/TC balance	2-in-1 reworkable	2-in-1 High SIR
Filler loading	NA	NA	30%	NA	10%	20%	46%	39%
Cure Temp./ Time, DSC	>8min @130dC	>8min @130dC	>10 min @150deg C	>10min @130dC	>10min @130dC	>10min @130dC	>10 min @150degC	>10min @150dC
Viscosity, mPa s,	380	360	520	354	350	520	530	800
Tg (° C), by TMA	102	113	119	123	131	130	117	123
CTE1, ppm/ ° C	64	55	43	61	52	52	37	45
CTE2, ppm/ ° C	181	171	136	190	185	171	147	160
Storage modulus, 25dC, GPa	2.99	3.25	5.0	2.45	3.00	3.2	4.6	4.1
Flow T	RT	RT	RT	RT	RT	RT	RT	RT

UF3927: 室温流动, 低CTE, 可返修; 优异的85/85 SIR及温循可靠性

汉高底部填充胶UNDERFILL

产品家族---高可靠性全底填

Item	E1216M	3563	FP4526	FP4531	E1172A	UF1173	-40	4F-6
Appearance	Black	White	Blue	Black	Tan	Black	Tan	Tan
Filler loading	35%	40%	63%	62%	63%	63%	65%	35%
Cure Temp./ Time, DSC	10min@130dC 5min@150dC	>7min@150dC >5min@165dC	>15min@1 65dC	7 min @160dC	5min @150dC	5-10 min @150dC	10min @120dC	15min @120dC
Viscosity @25°C, mPa s,	4,000	7,000	4,700	10,000	18,000	7,500	3,000	6139
Pot life @25°C, days	5days	12hrs	36hrs	24hrs	2 days	2 days	24hrs	24hrs
Tg (° C), by TMA	115	130	133	150	135	155	155	135
CTE1, ppm/° C	45	35	33	28	27	25	26	29
CTE2, ppm/° C	145	110	101	104	73	58	60	67
Storage modulus, 25dC, GPa	5.23	-	8.5	7.6	8.38	10.9	6.7	9.6
Pre-heating	60-80dC	80-100	80-100dC	60-80dC	80-100dC	80-100dC	70-100	70-90

-40: 高Tg, 低CTE, 低温固化, 流动性好, 适合大尺寸芯片要求高可靠性的应用场景

4F-6: 低介电常数Dk 2.2; 高Tg & 低CTE, 高可靠性, 适合高频信号传输相关应用场景

汉高底部填充胶UNDERFILL

产品家族---部分填充

Product	3128	UF1175	48NR-4	FP4535	UF 3711
Production Description	Reworkable EB	Controllable partial flow UF	High relia. & reworkable EB	High relia. EB	UV edgebond
Chemistry	Epoxy	Epoxy	Epoxy	Epoxy	Epoxy
Appearance	Black	Tan liquid	Tan	Black	Milky white
viscosity, cps at 5rpm	35,550	38,000	8,678 (20rpm)	12,1000	31,000(15s ⁻¹)
TI	2.87	1.05	>5	>5	>5
Cure Profile	20min @ 80dC 5min @ 130dC	15min @ 120dC	15mins @ 130°C	15mins @ 130°C	365nm 7000mJ/cm ²
Tg	38	151	122	145	140
CTE1 (ppm)	40	26	46	21	20
Storage modulus, GPa	3.6	8.3	4.96	9.70	12
Halogen Free	Yes	Yes	Yes	Yes	Yes
Reworkability	Good	No	Good	No	YES

UF1175: 高可靠性部分填充underfill，推荐大尺寸芯片可靠性提升应用

48NR-4: 平衡的返修和可靠性，推荐大尺寸芯片兼顾可靠性和返修应用场景

FP4535: 高Tg & 低 CTE，推荐应用于高可靠性，对返修无特别要求的应用场景

UF 3711:高Tg & 低 CTE，UV固化，推荐应用于温循可靠性提升，以及热固工艺难以实现的应用场景

汉高底部填充胶UNDERFILL

产品家族---导热型产品

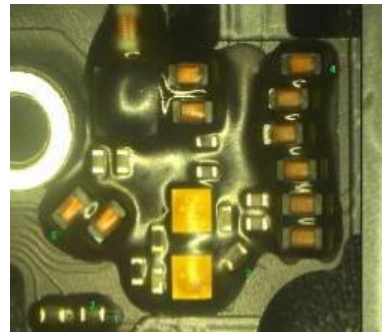
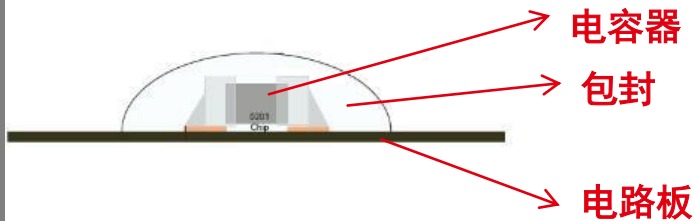
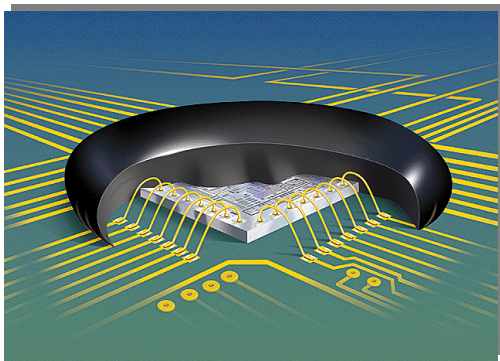
Item	UF4550HTC	UF4551HTC
Chemistry	Epoxy/Anhydride	Epoxy/amine
Appearance	White liquid	White liquid
Filler loading	76%	73%
Pot life @ 25dC	12 hrs	24 hrs
Cure profile	15min @160degC	5-10min @150-160degC
Viscosity @25°C, mPa s, • CP51/5rpm	13,500	10,149
Tg (°C), by TMA	148	137
CTE1, ppm/ °C	25	21
CTE2, ppm/ °C	101	84
CTC, W/m-k	1.2	1.3
Storage modulus, GPa @25dC	9.6	9.1
Preheating T, dC	90-110	70-100

UF4550 HTC & 4551HTC : 导热型underfill, 推荐应用于对导热有要求, 如立体封装的应用场景

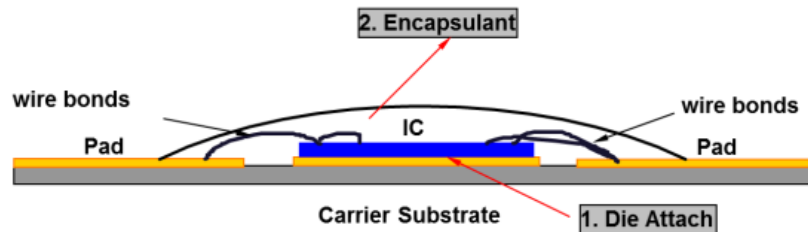
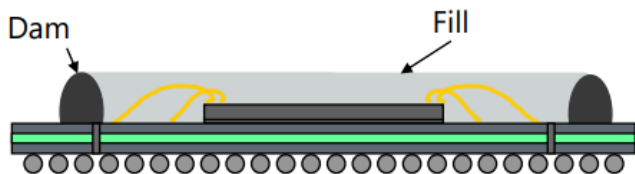
COB&元器件包封胶解决方案

包封胶产品是一种有着精确的流动控制、通过加热或紫外线固化的液体（环氧、丙烯酸酯或硅）材料。固化后，材料可以覆盖元件并提供：

- 防潮保护
- 吸收机械应力，避免芯片在装配，运输或工作中受到损伤
- 高温高湿、高低温循环，高低温冲击的可靠性提升
- 在二次回流焊锡流程中提供焊锡材料溅出或溢出保护，避免电气故障



汉高COB 包封解决方案

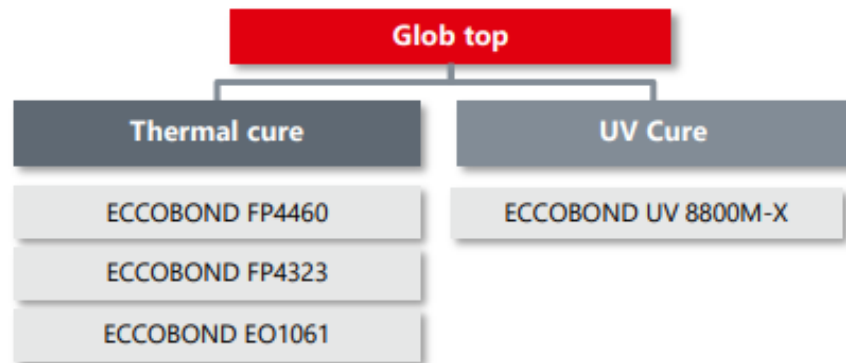
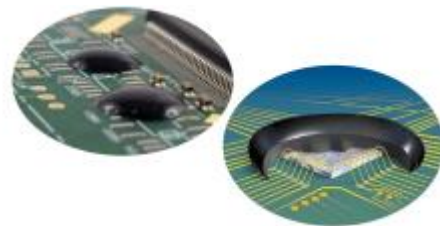
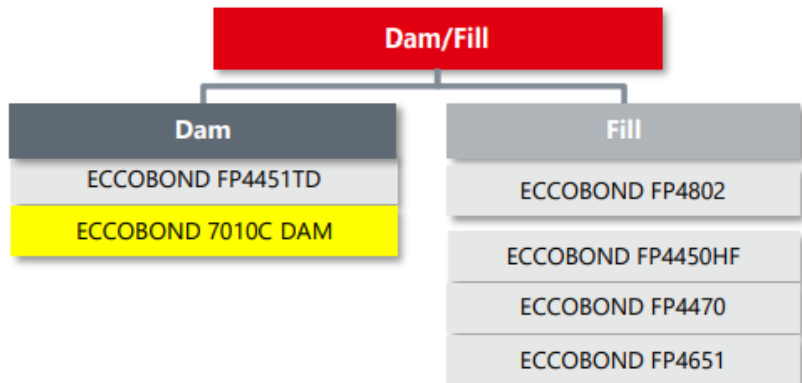


Dam/Fill – 先打框再用低粘度胶填内部, 能比glob top 较好的控制用胶位置

Glob top - 单一胶体

选胶重点: 包封尺寸, 基材特性, CTE, 固化条件, 可靠性条件, 是否重工...等

汉高COB 包封解决方案



- COB包封产品特点：低CTE, 高TG, 高模量, 低离子含量等, 高的可靠性

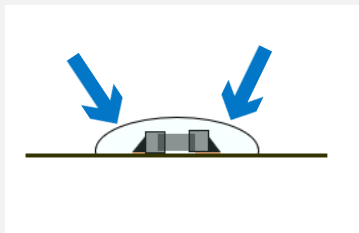
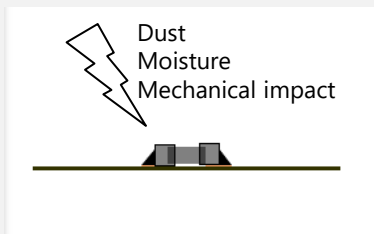
元器件ENCAP包封胶应用

为什么需要Encap:

- 提升机械可靠性
 - 无源器件 (电容、电阻、电感等)
 - 焊点电气连接保护
- 环境可靠性: 湿气、水, 化学防护等

Component Protection

Encap for moisture, water, stress protection



元器件封装胶的优点

■ 较好的机械性能和长期可靠性

- 多种基材上有强大的粘结力
- 更优秀的跌落测试性能

■ 简易的工艺性

- 优秀的喷射点胶性能
- 精确的流变控制，满足特定的流动需求

■ 双重固化

- 需要双重固化或阴影固化
- 更快的二级固化机制

■ 抗高温高湿

- 85C/85RH环境下有高SIR
- 可以承受严酷的环境
- 可以承受无铅回流

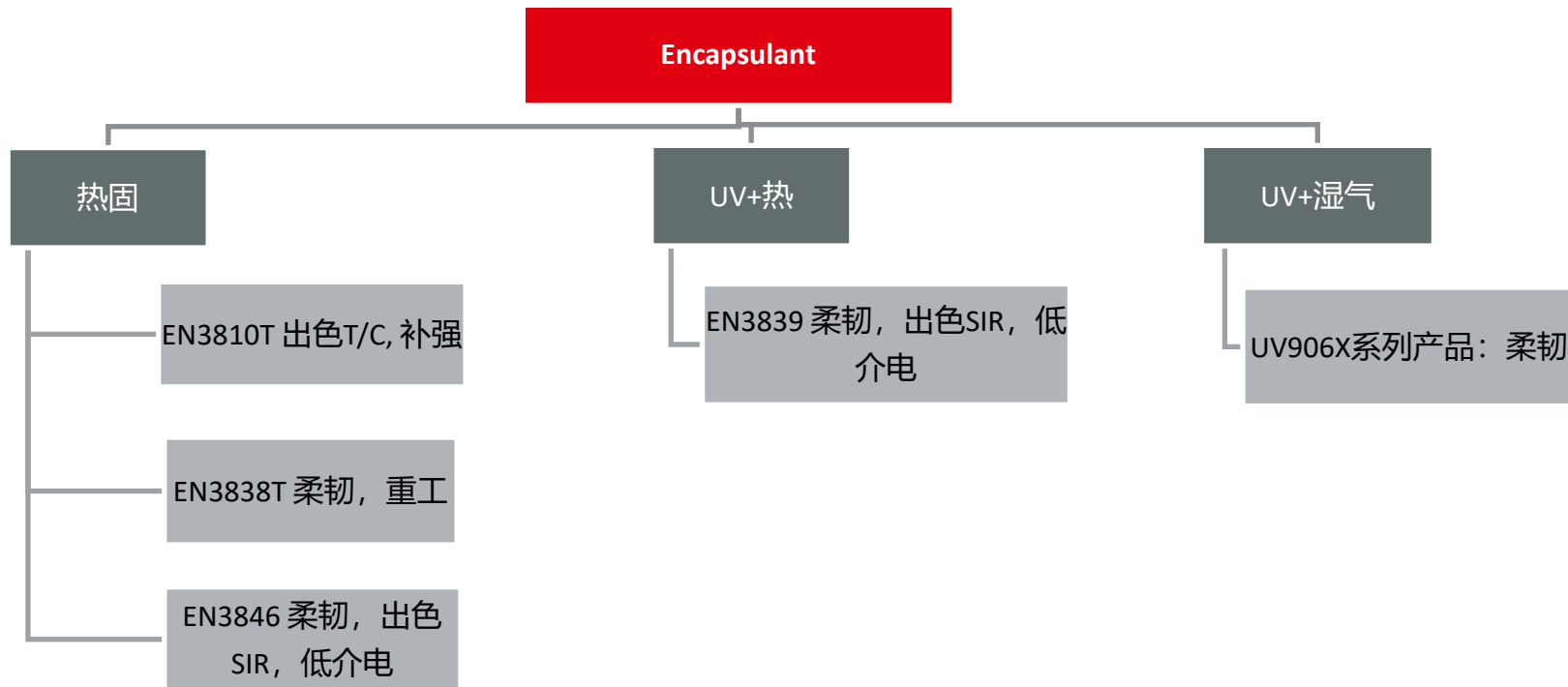
■ 易返修（制造业的高需求）

- 制造业的高需求

■ 环境兼容

- 单个元素<900ppm，总体<1500ppm
- ROHS

元器件ENCAP包封胶应用



元器件ENCAP包封胶应用

Product	Curing Method	Shape Control	Flexible	T/C	SIR	Low Dk	Rework
EN3810T	Thermal	Good	N	N.A.	Good	N	Hard
EN3838T	Thermal	Good	Y	N.A.	Moderate	N	Excellent
EN3846	Thermal	Good	Y	N.A.	Excellent	Y	Excellent
EN3839	UV + Thermal	Good	Y	N.A.	Excellent	Y	Excellent
UV9060F	UV + Moisture	Good	N	N.A.	Good	N	Hard

应用相关材料关键物化参数及可靠性测试

Rheology 流变

- 旋转粘度计
- 流变仪

Mechanical and Chemical 物化特性

- DSC 差示扫描量热法
- TGA 热失重
- TMA 热膨胀系数测试
- DMA 动态热机械分析
- DSS 芯片推力测试

Dispensing 点胶工艺

- Jetting 喷射点胶
- Air pressure 气动点胶

Reliability 可靠性

- SIR 表面绝缘电阻
- Drop test 跌落可靠性测试
- Thermal cycle 高低温循环

Rework 返修

- Rework 返修评估

RHEOLOGY 流变

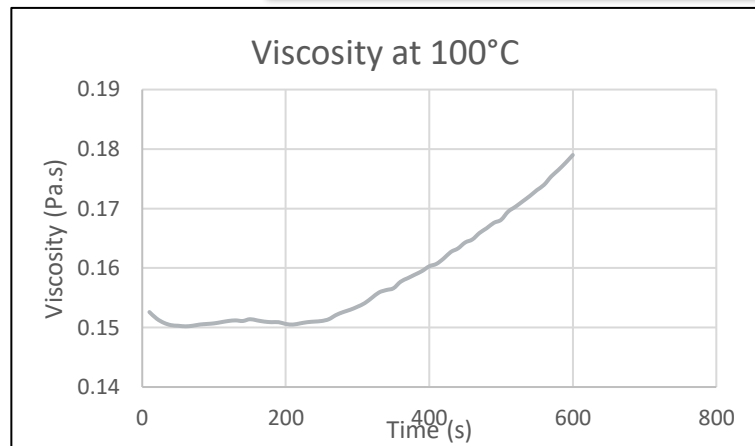
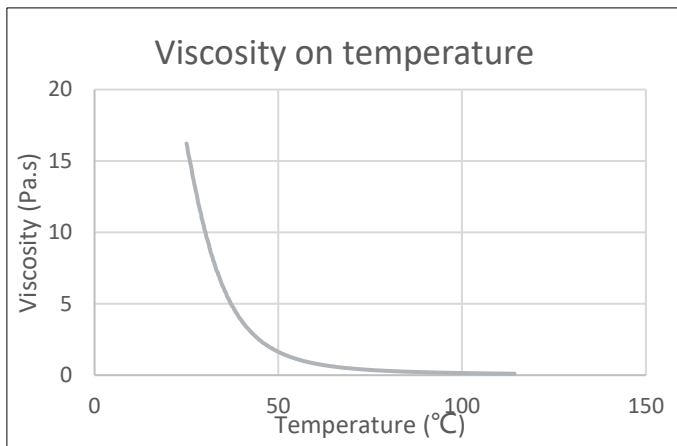
UF 1173

Test method:

Dynamic and Isothermal

Test parameter

- Dynamic: ramp to 150 °C, stop when the viscosity increases rapidly
- Isothermal: ramp to 100°C and keep for 10 min.



MECHANICAL AND CHEMICAL 物化特性

UF 1173 TMA

Test method:

TMA

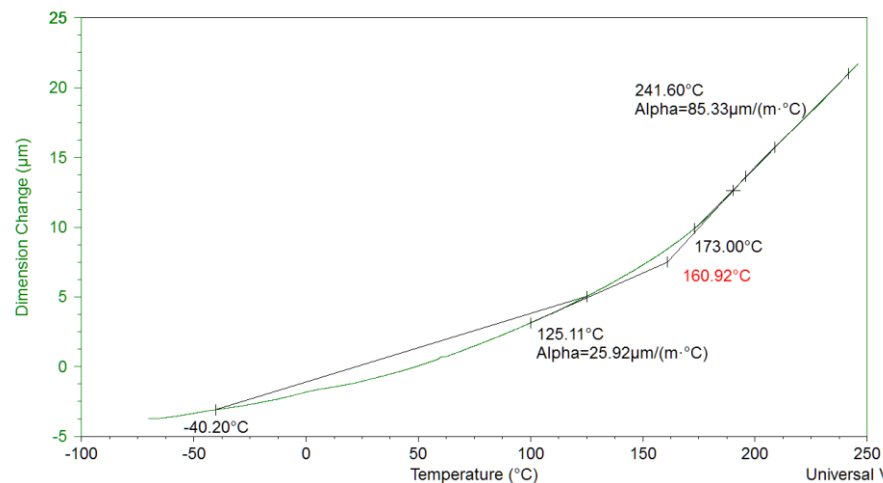
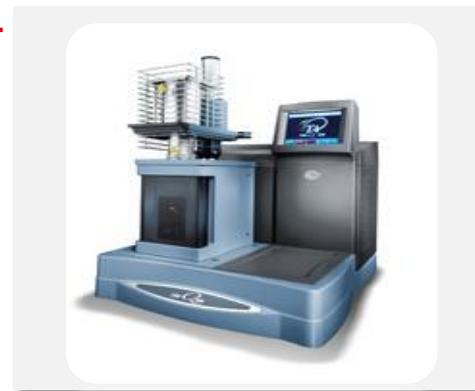
Test parameters

Sample size:

height: 4.5 mm

diameter: 3.5 mm

Profile: -70°C to 250°C at 10°C/min.



Universal V4.5A



MECHANICAL AND CHEMICAL 物化特性

UF 1173 DMA

Test method:

DMA

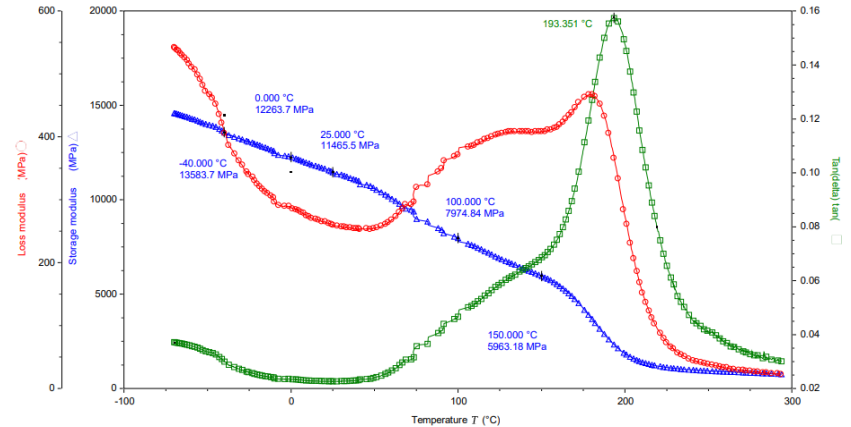
Test parameter:

Sample size:

17,5mm*10,5mm*5,08mm

-50°C to 250°C at 5°C/min,

frequency 10HZ



固化: 150C*15min

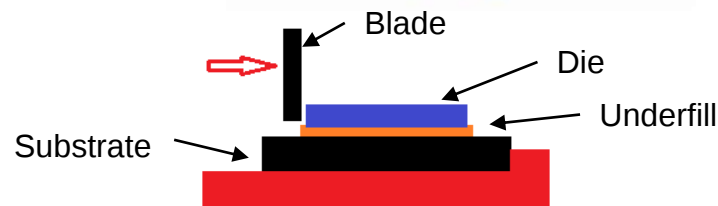


MECHANICAL AND CHEMICAL 物化特性

UF 1173 DSS芯片推力

Test method:

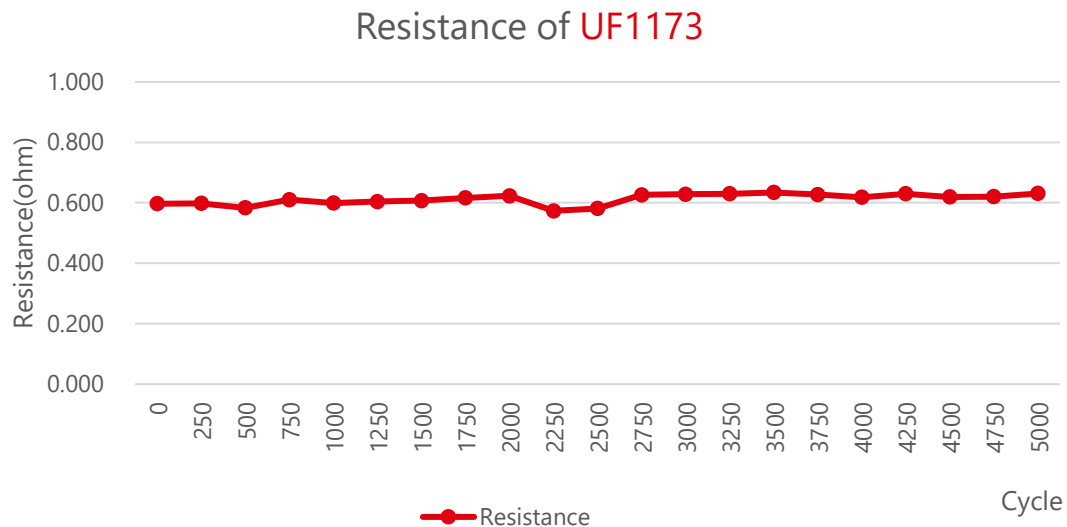
- Substrate: FR4, Glass
- Die size: 12mm*12mm
- Test T: 25°C
- Record the force when the die fly away.



Adhesion force	FR4	Glass
UF 1173	18kg	>30kg

RELIABILITY 可靠性

UF 1173 THERMAL CYCLE 高低温循环可靠性



⇒ Passed 5000 cycles air to air thermal shock of -40/150°C

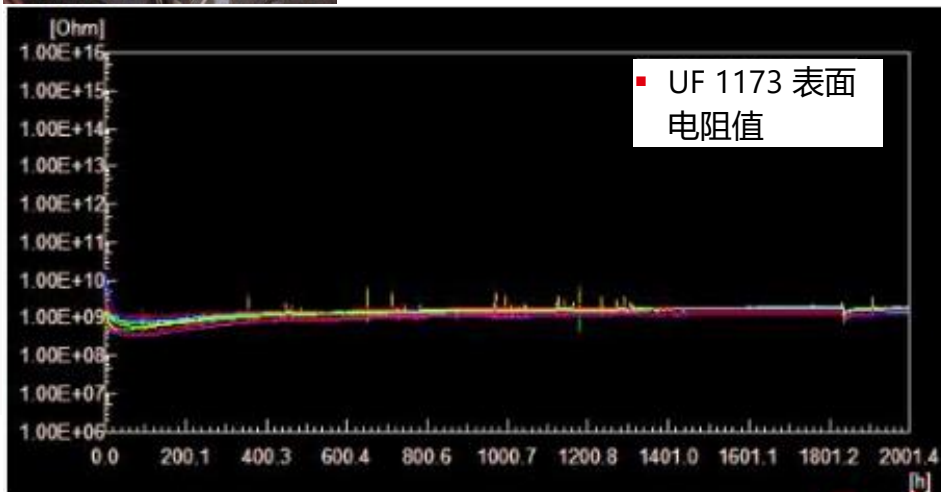
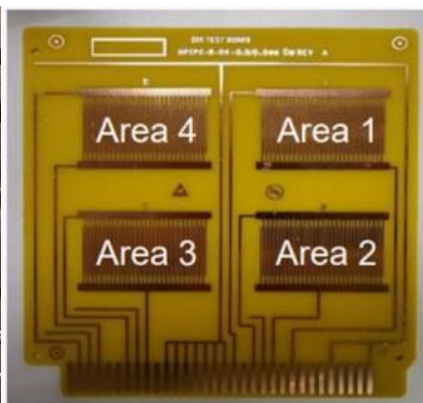


Henkel

RELIABILITY 可靠性

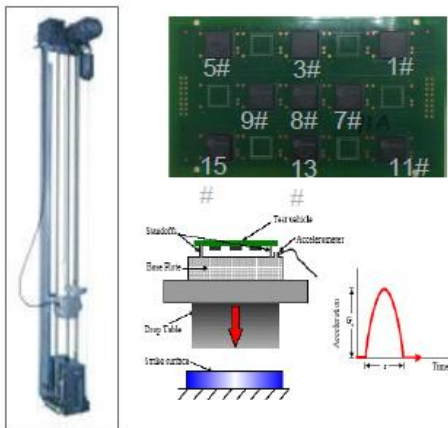
SIR 表面绝缘电阻

- Substrates
 - SIR test board: MP IPC-B-24 REV A
- Solder paste: Indium 256 8.9HF
 - Thickness: 3 mil
 - Reflow profile: Normal linear
- SIR Test condition for Auto
 - 85°C/85RH for 2000hrs
 - Bias: 50V
 - Measurement: 100V
 - Material thickness: 0.15mm
- SIR Test condition for Consumer
 - 65C/90%RH, 168 hrs(7days)
 - Bias: 6V,
 - Measure voltage: 50V
 - Material height: 0.3mm



RELIABILITY 可靠性

DROP TEST 跌落可靠性测试



Test method:

Lansmont Model 15-D Shock Tester

JEDEC 22-B111, dropping 2900 Gs, 0.27 msec Pulse

Failure: 20% increase in resistance

Components: 12x12mm CTBGA, 0.5mm pitch

Board: 1.0 mm Thick FR-4

Material	10 Cycle	20 Cycle	50 Cycle	100 Cycle	200 Cycle	400 Cycle	600 Cycle	800 Cycle	900 Cycle	1000 Cycle
NO UF	0/9	2/9	5/9	8/9	9/9	9/9	9/9	9/9	9/9	9/9
UF3808	0/9	0/9	0/9	0/9	0/9	0/9	0/9	0/9	1/9	1/9
UF3812	0/9	0/9	0/9	0/9	0/9	0/9	0/9	0/9	0/9	2/9
UF3912	0/8	0/8	0/8	0/8	0/8	0/8	0/8	0/8	0/8	2/8
UF3831	0/9	0/9	0/9	0/9	0/9	0/9	0/9	0/9	2/9	4/9

REWORK 返修

返修工艺

Process

Component Removal Stage

Preheat board (100 sec)



Reflow Component to
230°C (100 sec)



Use Manual Tools to De-bond
Component

Board Cleaning Stage

Apply Tacky Flux on Target Site



Scrape underfill residue from
board surface

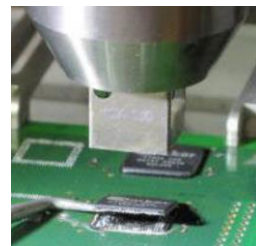


Pick up remaining UF residue
with Flux saturated Cotton swab



Cool down board and wipe with
solvent

Typical re-work time no more than 5 minutes



THANK YOU.



[FIND OUT MORE ON HENKEL.COM](https://www.henkel.com)