





Enhancing the Punch MLF[®]/QFN Package for Improved Robustness in Automotive Applications

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Agenda

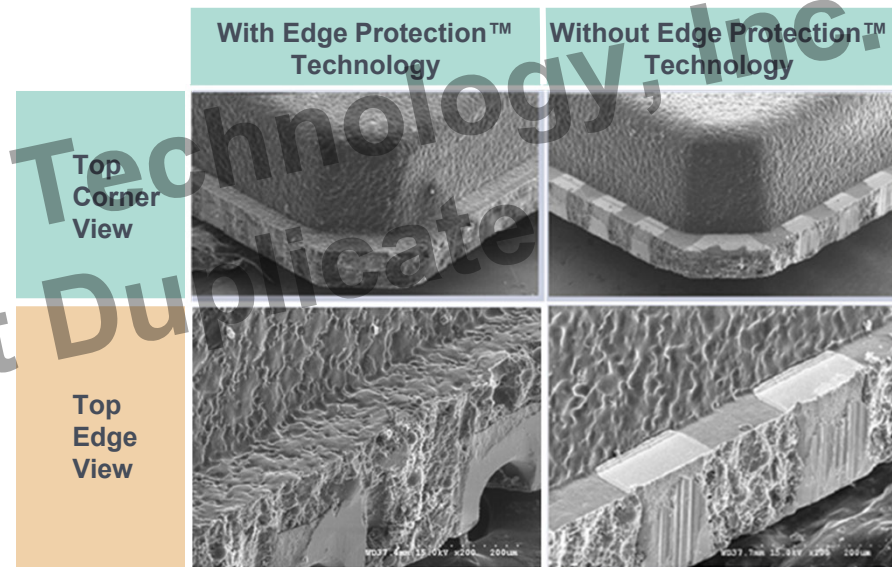
- 1 Introduction of Edge Protection™ Technology (EPT)
- 2 Punch QFN Package Crack/Gap Phenomena
- 3 Evaluation of the EPT Solution
- 4 Implementation of EPT
- 5 Conclusions | Q&A

Introduction of Edge Protection™ Technology (EPT)

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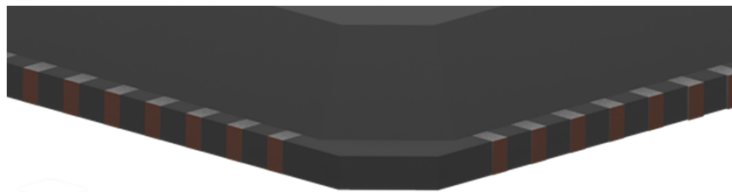
Introducing Edge Protection™ Technology for pMLF®

- ▶ pMLF® exposed flange area is susceptible to stress during the punch singulation process, shipping, and/or during test socket insertion
- ▶ Edge Protection™ Technology (EPT) is an additional 0.1 mm thick EMC molded onto the exposed flange area during the mold process
- ▶ Improves constructional robustness of the pMLF®/QFN



Edge Protection™ Technology for pMLF®

Current Profile



- ▶ Current profile has top of leads exposed on the flange
 - ▶ Susceptible to damage during handling operations

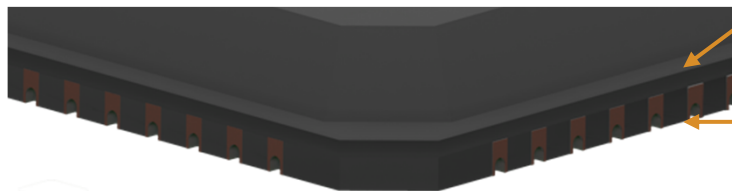
With Edge Protection™ Technology Applied



Additional
0.1 mm
thick mold

- ▶ Edge protection technology is an extension of the existing mold cap, adding 100 µm of EMC to cover the top exposed leads

Edge Protection™ Technology + Dimples



Additional
0.1 mm
thick mold

Dimples for
wetable flanks

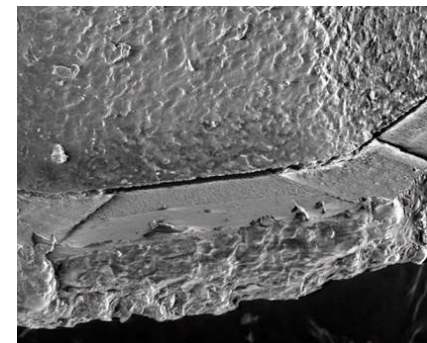
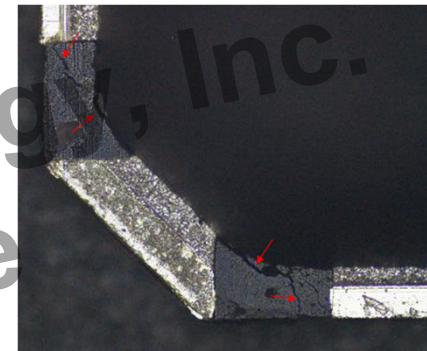
- ▶ Adding dimple wettable flanks results in a best-in-class automotive MLF® solution

Punch QFN Package Crack/Gap Phenomena

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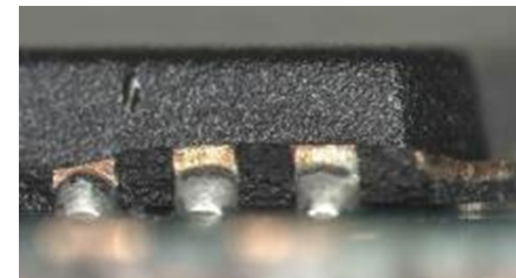
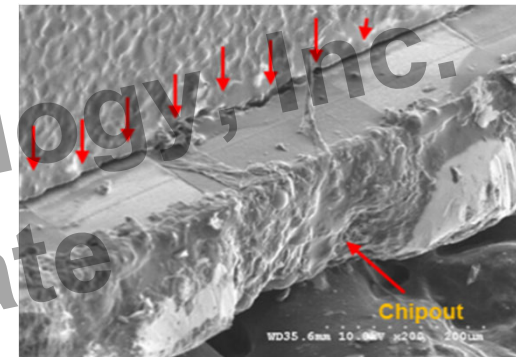
Crack & Gap Phenomena

- ▶ Historical concern for punch MLF[®]/QFN
- ▶ Seen as low PPM failure mechanism on corners and along the edges of the exposed leadframe top flange area
- ▶ Detection using traditional optical inspections is very challenging
- ▶ Separation of EMC from leadframe
 - ▷ May enable a moisture ingress path
 - ▷ May lead to wirebond failures



Historical Causes of Crack & Gap

- ▶ Handling
 - ▷ Leadframe deformation occurring during assembly processes
 - ▷ Shipping – specifically the tray design
- ▶ Punch singulation
 - ▷ Punch blade wear
 - ▷ Leadframe clamping
- ▶ Test insertions
 - ▷ Burn-in socket design
 - ▷ ATE contactor design
 - ▷ Handler placement control & accuracy

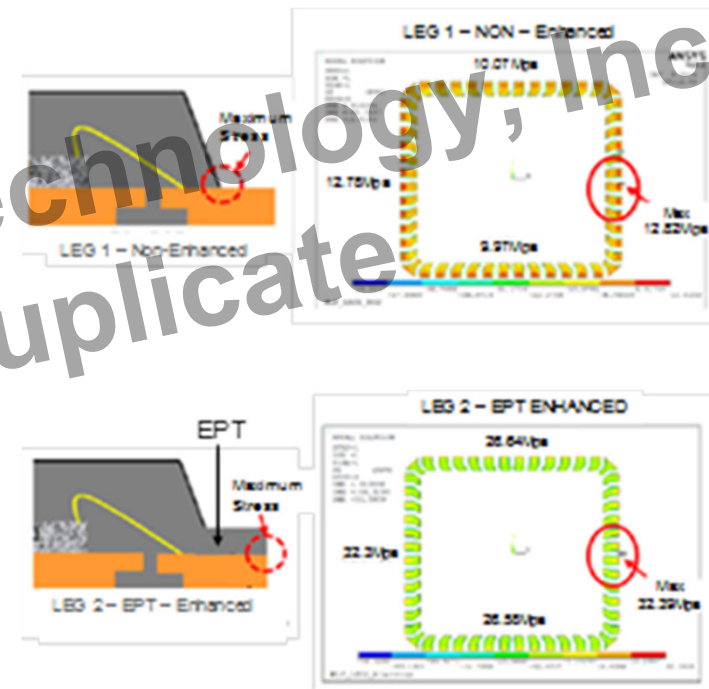


Evaluation of the EPT Solution

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Strength and Robustness Testing

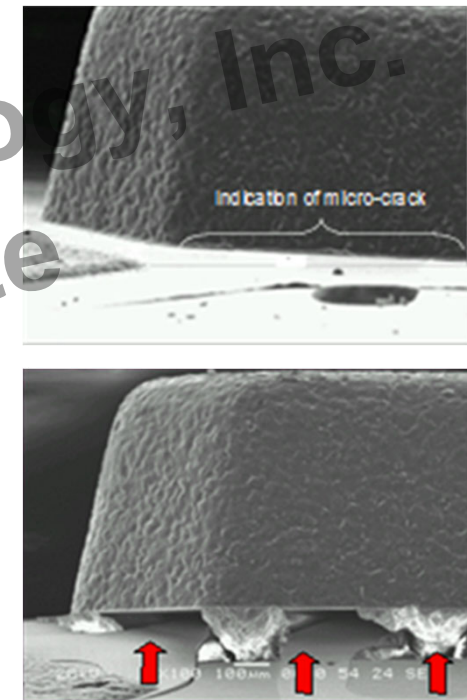
- ▶ Finite element model created to identify stress points of the punch package with and without Edge Protection™ technology (EPT)
 - ▶ EPT isolated stress points away from the critical EMC to leadframe interface
 - ▶ Results indicated EPT enhancement improved crack/gap resistance of the flange area by 3x



Strength and Robustness Testing

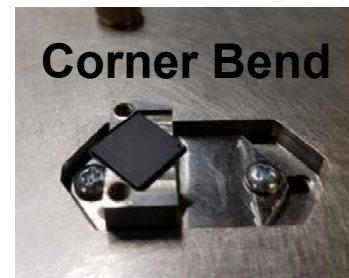
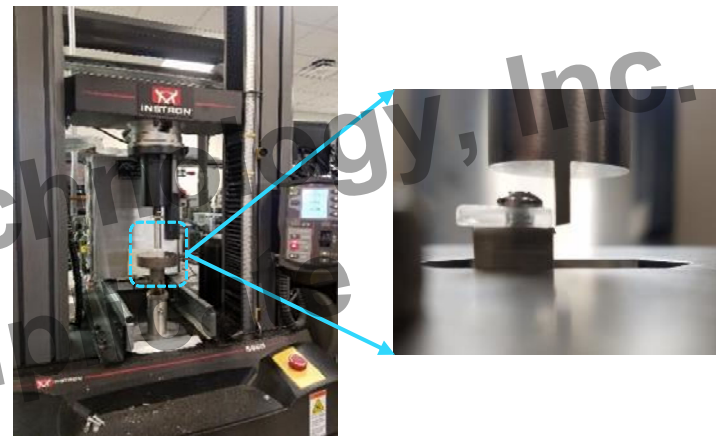
- ▶ Empirical data collection
 - ▷ Evaluation designed to validate the simulation
 - ▷ 5 x 5 mm, 16 ld device used as test vehicle
 - ▷ Calibrated force ram used to apply force from 500 gf to 1500 gf
 - ▷ First failures detected at 600 gf
 - ▷ Catastrophic failures seen at 1500 gf

1 gf = 0.0098 newtons (N) = 0.0022 pounds-force (lb-f)

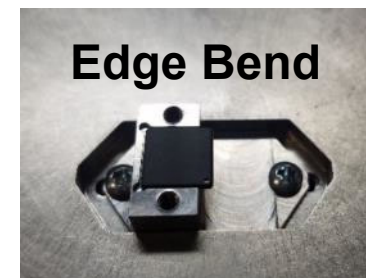


Strength and Robustness Testing

- ▶ Laboratory testing
 - ▶ Laboratory conditions used to validate simulation and empirical data
 - ▶ Custom, computerized fixture designed and fabricated to ensure repeatability of test conditions
 - ▶ Corner bend and edge bend testing conducted
 - ▶ Three body sizes used for testing
 - » 7 x 7 mm, 8 x 8 mm & 10 x 10 mm



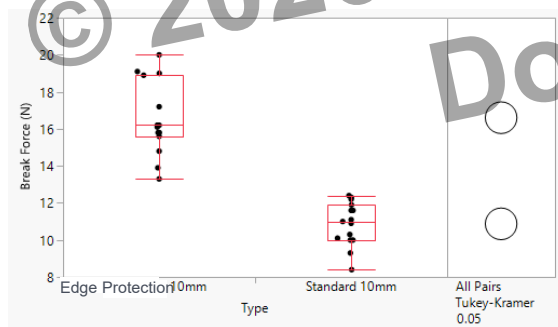
Corner Bend



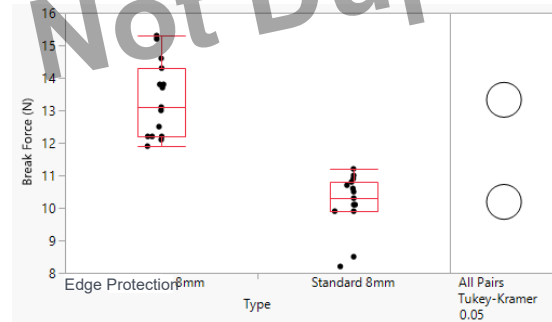
Edge Bend

Edge Protection Strength Improvement

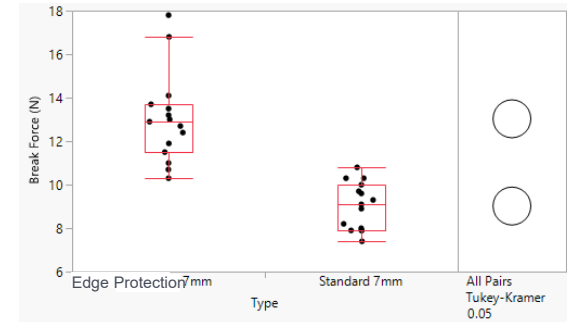
- ▶ Extensive testing has shown >2x improvement to strength of flange and corner areas
- ▶ Side-by-side testing of enhanced and non-enhanced single row devices completed for three body sizes
- ▶ Results show consistent and significant improvement across body sizes tested



10 x 10 mm



8 x 8 mm



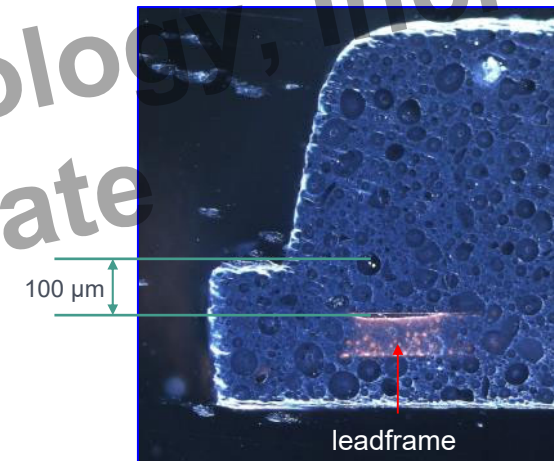
7 x 7 mm

Implementation of Edge Protection™ Technology

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Punch MLF[®] with Edge Protection[™] Technology

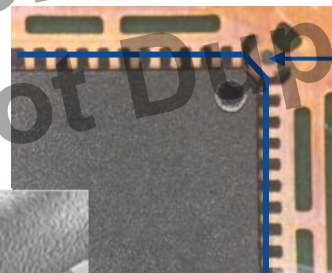
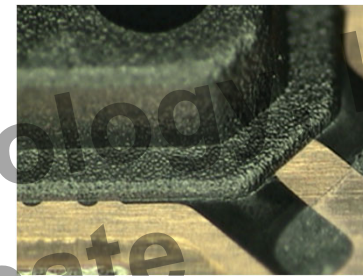
- ▶ EPT forms a 100 μm EMC cover over the top flange area of the punch MLF[®]
 - ▷ Mold chase design modification to mold cap only
 - ▷ No change to existing leadframe design
 - ▷ No change to singulation tooling
- ▶ Form, fit & function of the package remains unchanged
- ▶ Implement on dual row version of punch MLF[®] first
 - ▷ Fully qualified internal Amkor as well as end users
 - ▷ >500M units of various body sizes & lead counts without incident of crack & gap



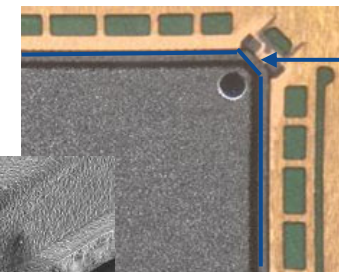
Using Edge Protection™ Technology

Customer considerations

- ▶ Package Outline Drawing (POD)
 - ▷ Minor modification to mold cap only
 - ▷ No change to POD
 - » Identical singulation parting lines
- ▶ EOL & test hardware
 - ▷ ATE
 - » No impact
 - ▷ Burn-in
 - » No impact
 - ▷ Tape & reel
 - » No impact



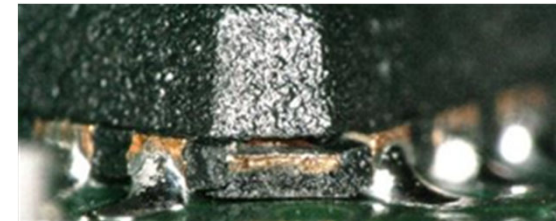
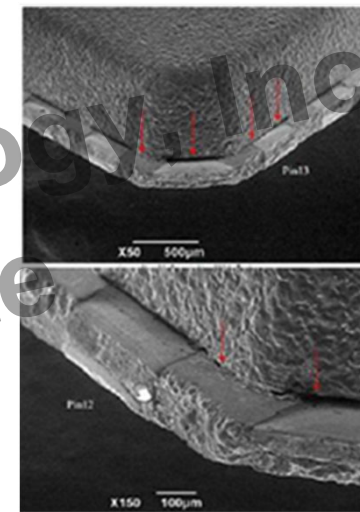
Standard
Punch MLF®



Punch MLF® with
Edge Protection™
Technology

Quality Benefits of Edge Protection™ Technology

- ▶ Significantly reduces the possibility of gaps/cracks resulting from mechanical stress
 - ▷ Added protection for all handling procedures
- ▶ Significantly improves the package strength
 - ▷ Robust performance during burn-in and electrical ATE test insertions
- ▶ Elimination of SMT related incidents
 - ▷ Placement equipment only touches EMC – no contact of the leadframe during placement





Edge Protection™ Technology for Automotive Applications

- ▶ Minor modification intended to improve the robustness of the punch MLF® package
- ▶ Improvement justified as the punch MLF® continues to be the preferred format for automotive applications
 - ▶ Dimple for wettable flanks
 - ▶ Individual mold cavities for greater wirebond flexibility – complex layouts and wire lengths
 - ▶ More cost effective overall when compared to alternative solutions





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Thank You

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