

## Achieving Success in Automotive Leadframe Packages

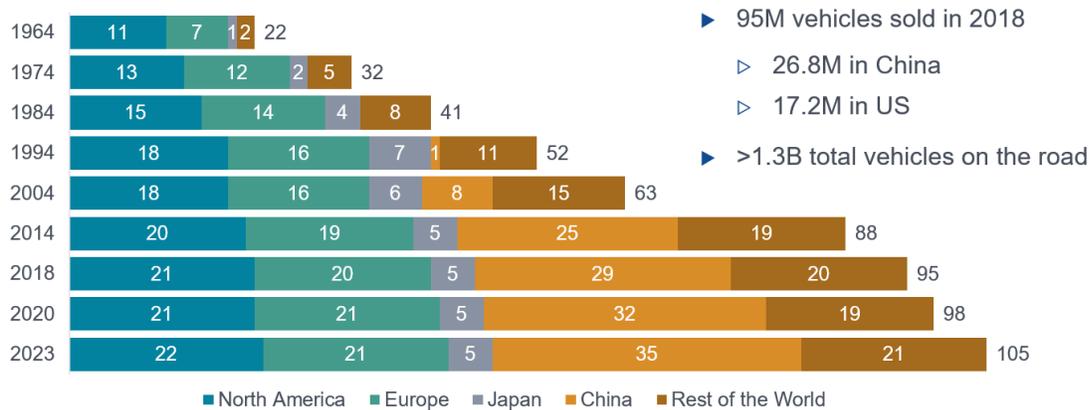
John Nickelsen, VP, Product Engineering Amkor Technology, Inc.

The growth of semiconductor content in automotive applications has been accelerating. This growth drives all families of [semiconductor packaging](#) in all regions. The growth is happening in the latest advanced, laminate-based packages using [flip chip](#) interconnect as well as the venerable leadframe packages using wirebond interconnect. The automotive market consumes micro-electromechanical systems ([MEMS](#)) packages as well as leadframe packages such as Quad Flat Pack ([QFP](#)) and Small Outline Integrated Circuit ([SOIC](#)) packages and the fast-growing [MicroLeadFrame](#)<sup>®</sup> (MLF<sup>®</sup>)/Quad Flat No-Lead QFN packages. Increasingly, the industry depends on Outsourced Assembly and Test (OSAT) suppliers to provide wire bond leadframe packaging support. [Amkor Technology](#) is the leading OSAT supplying packaging for the automotive industry and particularly leadframe-based packages.

In addition to growth, [quality](#) and reliability requirements of the automotive market have increased significantly. Among other things, automotive customers demand zero defects and zero delamination after extended reliability testing. To achieve success with automotive leadframe packages, Amkor has invested and continues to invest substantial resources in two strategic directions.

## Automotive Unit Sales Growing

(Units in millions)

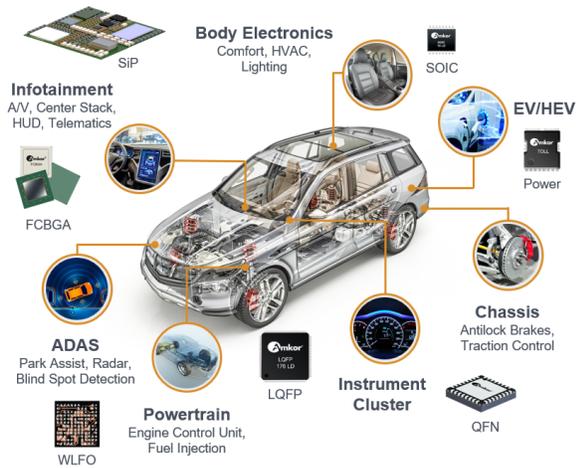


**Source:** IHS Automotive/Polk; Ward's Auto InfoBank; McKinsey analysis

# Automotive Packaging

## Advanced Packages

## Wirebond Packages



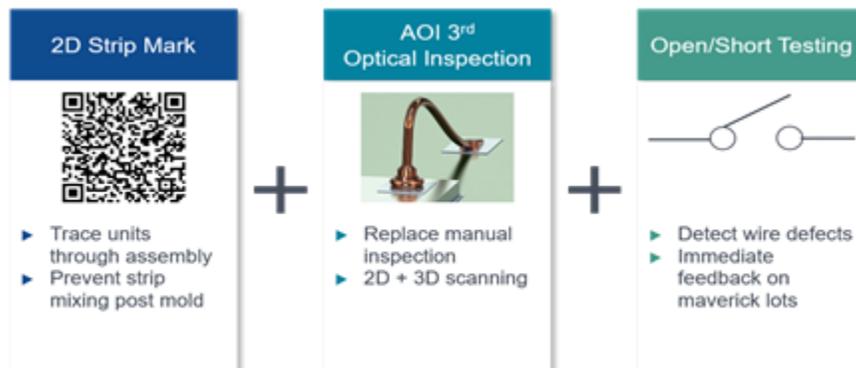
## Accelerated Adoption of Advanced Packaging

Analog	Sensors	MCU, GPU	RF/mmWave Transceivers	Processor + Memory
Amkor TOLL Power	Amkor Overmolded	Amkor LQFP MCU, GPU	Amkor RF/mmWave Transceivers	Amkor SiP
Amkor Dual LF	Amkor Exposed Die	Amkor CABGA	Amkor fcCSP	
Amkor MLF <sup>®</sup>	Amkor Cavity		Amkor WLFO	
	Amkor Optical Sensor		Amkor FCBGA	

Source: Amkor

## Automotive Process Enhancements

The first strategic direction is the development of automation tools to significantly reduce escaped defects. Defect trapping/isolation has been improved by marking tracking identification on leadframe strips prior to the start of assembly. The tracking marks are then used to create defect maps when automatic optical inspection (AOI) is performed following wire bonding and again during sample open and short (O/S) [electrical testing](#) after the completion of assembly. In addition to preventing defective parts from escaping, these automatic inspections provide rapid feedback to the process engineering team in the factory. In the case of the defects caught at AOI, there is a photographic record of all defects found that the engineering team can use to troubleshoot the issue without the need for further failure analysis. Customers are reporting an increase in their final test yield as assembly-related defects are screened out. After a decrease in yield when AOI and OS were initially introduced, the fast feedback supports ongoing assembly continuous improvements by leveraging the fast feedback provided.



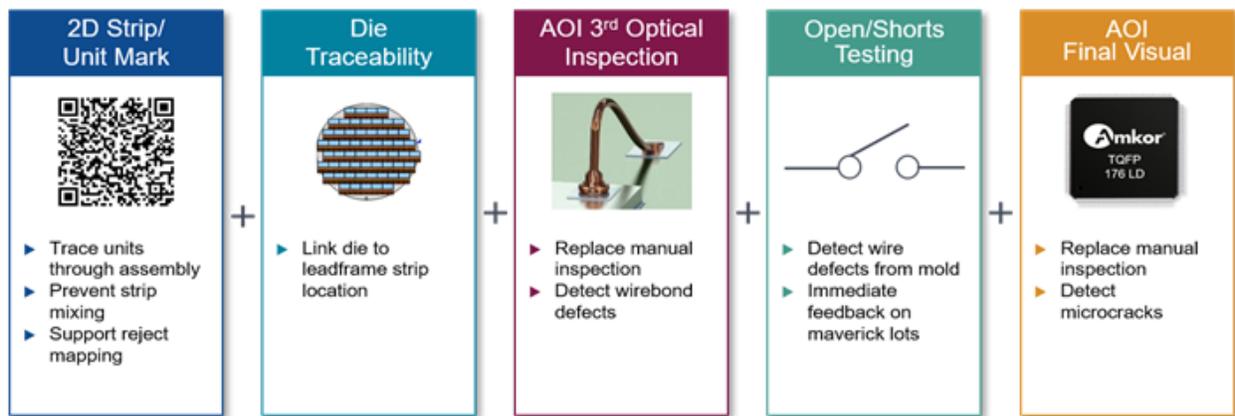
**Figure 1. Defect Trapping/Isolation**

As a part of the plan for extending implementation of automation for the automotive market, Amkor is currently developing support for Die Traceability Systems (DTS) for leadframe products as a first step towards Unit Level Traceability ([ULT](#)). DTS leverages the equipment and processes put in place to

support defect trapping (2D marking, AOI at 3rd OP and OS) with the addition of integration of the die attach equipment with the strip mark tracking to link the customer electronic wafer map to leadframe strip maps. This creates a record of which die are placed on which leadframe locations. Unit laser markers near the end of the assembly process then mark a 2D code on the package identifying the package and linking it to the information about the die and wafer as well as the defect maps generated during the assembly process. DTS records will be electronically transferred to customers as needed. Once support for DTS has been completed, Amkor will expand the strip level traceability and mapping over time to all other assembly process stations to eventually be able to provide ULT.

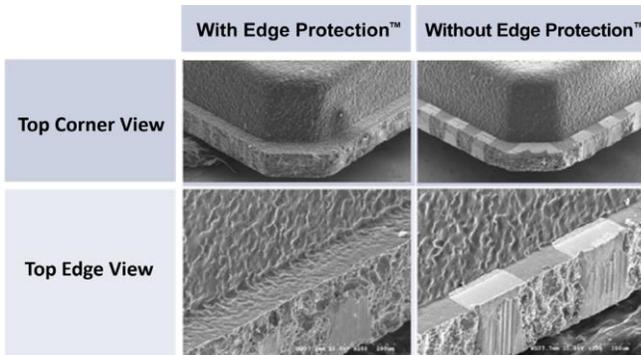
### Standard Product Definitions for Automotive

The second strategic direction has been the development of the capability for leadframe packages to consistently achieve zero delamination following extended automotive reliability (AEC Q100 & Q006 G1 & G0) testing. Many different combinations of processes and materials were tried before consistent results were achieved. With the initial success of these efforts, further implementation is occurring across the broad portfolio of leadframe packages. This success has been achieved by focusing on many factors including design, process, and environmental controls, as well as the interactions of physical properties of bill of material (BOM) elements. The design features that have been develop are based on a proprietary understanding of how to incorporate mold locking features along with the relative dimensions of key features including the plating of noble metals.



**Figure 2.** Die Traceability (DTS)

## Robust Design Features Supporting Automotive



**Figure 3.** Edge Protection™ Technology for pMLF® packages



**Figure 4.** Edge Protection™ Technology + Dimples

Amkor has also worked with our key material suppliers to develop proprietary die attach and mold compound formulations with matched physical properties. We have also developed an in-depth understanding of our leadframe suppliers plating and roughening capabilities, so that we can source the best solutions for automotive applications. Based on all these studies, Amkor has developed Standard Product Definitions (SPD) by package family which define the recommended BOM and process flow for packages that will be deployed in demanding environments such as many of those in the automotive market. The investment of significant resources in various areas has led to achieving success in the automotive leadframe marketplace.

Learn more about Amkor's leadframe packaging solutions here <https://amkor.com/leadframe>

Learn more about Amkor's Automotive solutions here <https://amkor.com/automotive>

*MicroLeadFrame*, MLF and pMLF are registered trademarks of Amkor Technology, Inc.

[Edge Protection](#) is a trademark of Amkor Technology, Inc.