Slide updated

DA5 Consortium

Customer Presentation

Slide updated

Updates to last version from 06.04.2022

- **The logo of the DA5 was updated on all slides**
- **Slides number 1, 2, 9, 12, 13, 14, 17, 28, 29, 30, 34, 36, 37, 40 and 41 updated**

Agenda

- **Motivation: Environmental and health endangerment by lead**
- Status on legislation
- Situation: Lead & the use in Electronics
- DA5 Structure and Project:
  - Cooperations and partners
  - Requirements, Applications and Approaches for possible solutions
  - Results
- Timeline and Conclusion

Lead: Environmental and Health Endangerment

- Environmental dangers:
  - Poisoning of water, air and soil

- Health dangers:
  - Neurotoxin
    - Accumulates in soft tissues & bones
  - Damage to nervous system
  - Causes brain disorder
  - Causes blood disorder in mammals
  - Further information can be found at: https://www.who.int/news-room/fact-sheets/detail/lead-poisoning-and-health

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Legislation I

- European **End-of-Life Vehicle (ELV) Directive (2000/53/EG)** mandates conversion to environmentally friendly materials. It sets clear targets for their reuse, recycling and recovery and aims to prevent and limit waste from end-of-life vehicles and their components and to improve the environmental performance of all economic operators involved in the life-cycle of vehicles
  - Annex II (2010/115/EU, exemptions 8(e-j) ELV 9th revision
  - In the last review of this exemption in 2018/19 under the ELV Directive in 2019 the consultants concluded that the use of lead in high melting temperature type solders (LHMTS) in Exemption 8(e) is still unavoidable in devices under the scope of the ELV Directive.
    The continuation of the exemption was therefore granted in line with the requirements of ELV Art. 4(2)(b)(ii).
    No expiration date was defined for the aforementioned exemption
  - EU COMM decided to extend exemption 8(e) until 2024. Automotive Industry Associations and DA5 supported the successful review process. Next ELV review is planned in 2023
  - The entry in the Official Journal was done in spring 2020
  - **Exemption may be cancelled if an alternative is available and proven**

Legislation II

- European **RoHS Directive (2011/65/EU)**
  restricts the use of certain hazardous substances in electrical and electronic equipment
  - RoHS exemptions allow temporary use of restricted substances.
    See Annex III in 2011/65/EU (RoHS-2) for exemptions
  - RoHS II Directive entered into force 21st of July 2011
  - Industry associations consortium(34 associations involved) sent an extension dossier regarding exemption 7(a) to the EU COMM on 16th of January ’15
  - The revision process was finished; regarding 7(a) the EU COMM and the EU Parliament decided to extend the exemption 7(a) to July 2021 using the same wording
  - Exemption 7(a) (lead in high temperature melting solders) valid until mid 2021 will automatically extend until EU COMM decides on running exemption extension process starting Jan. 2020 at the latest
  - The RoHS Umbrella Industry Project, more than 70 Industry Associations worldwide are involved, sent an extension dossier to the EU COMM before the January 2020 deadline
  - The EU COMM informed that the consultant will not start their assessment before end of December 2020
  - Stakeholder consultation on Pack 22 (which includes e.g. the exemption 7(a)) went from 23rd of December 2020 to 03rd of March 2021
  - Consultant (Oeko Institute) report published on 13th of January 2022
  - Details can be found at: https://ec.europa.eu/environment/topics/waste-and-recycling/rohs-directive/implementation-rohs-directive_en

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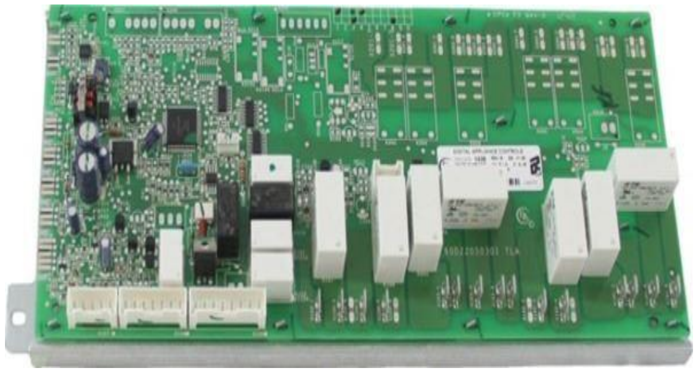
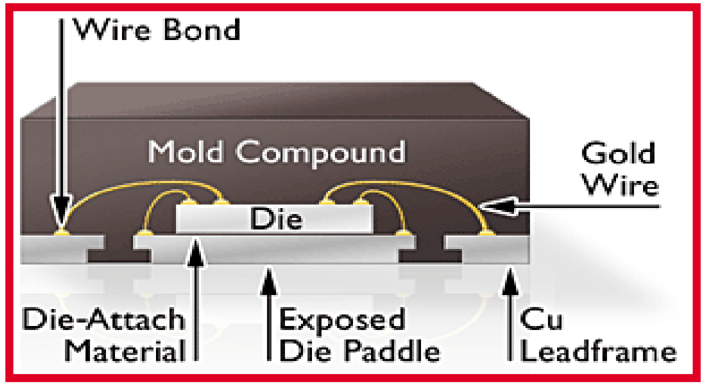
Use of Lead in Electronics

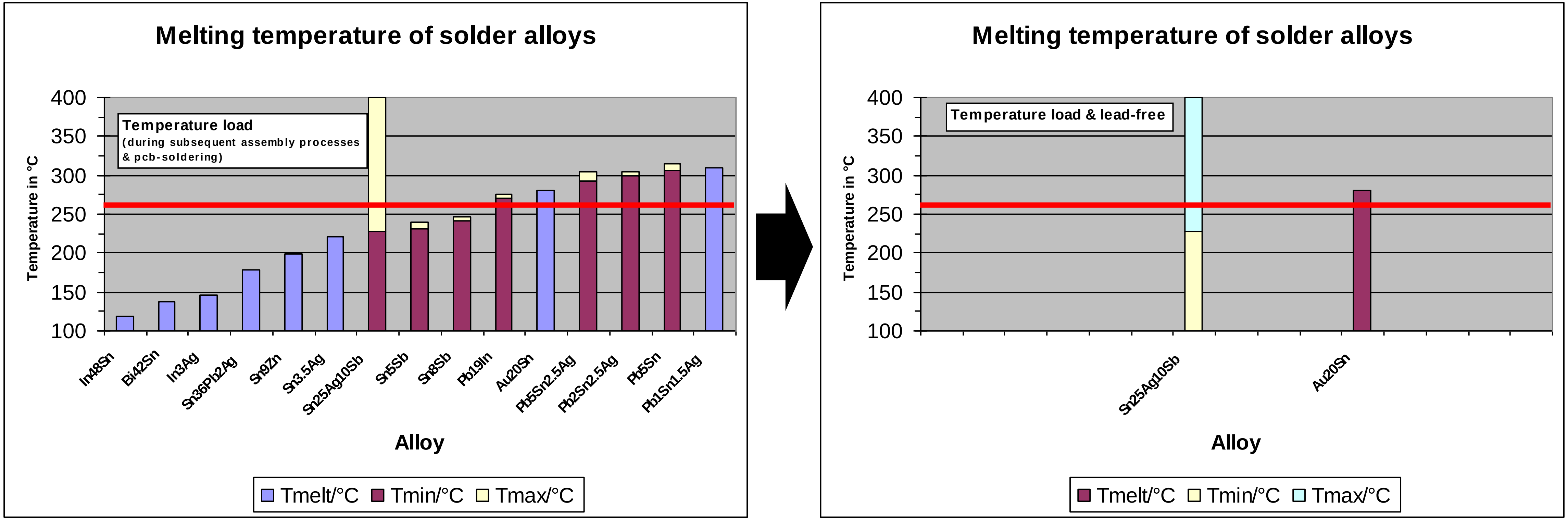
- Use of Lead containing Solders on PCB-level
  - **PbSn63 or PbSn62Ag2**
    are & have been used for soldering components onto a printed circuit board (PCB)
  - Lead-free alternative solders known & implemented
    - E.g. SnAg3.8Cu0.7 (SAC)



- Use of high Lead containing Solders on package-level
  - **PbSn5 or PbSn2Ag2.5** are used for die attach inside components
  - As of August 2022, there is no capable replacement for lead-solder available that fulfills the requirements
    - No re-melting during PCB reflow process (260°C)
    - Excellent wettability
    - Reliable due to ductility
    - Commercially competitive



Materials for Die Attach: Solder Alloys



- Brittleness of remaining alloys limits reliability to only smallest die sizes with severe constraints on chip thickness, package geometry and surface materials

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- **DA5 Structure and Project:**
  - **Sustainability Efforts**
  - **Cooperations and partners**
  - **Requirements, Applications and Approaches for possible solutions**
  - **Results**
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Sustainability Efforts I

Infineon:

We understand sustainability as the symbiosis between economy, ecology and social engagement. At Infineon, we responsibly manage the handling of hazardous materials to safeguard human health and environmental protection. As part of Infineon Group Policy for Environmental Protection, Energy Management, Safety and Health, we are moving towards supply chain responsibility, focusing on the purchase of new environmentally friendly materials in the manufacture of its products. Products manufactured by Infineon in the fields of automotive electronics, industrial drives, servers, lighting, photovoltaics, wind energy, mobile phone chargers and induction cookers, enable CO_2 emission savings amounting to approximately 72 million tons of CO_2 equivalents during their use-phase. For the twelfth time in a row, Infineon has been listed in the “Dow Jones Sustainability™ Index”.

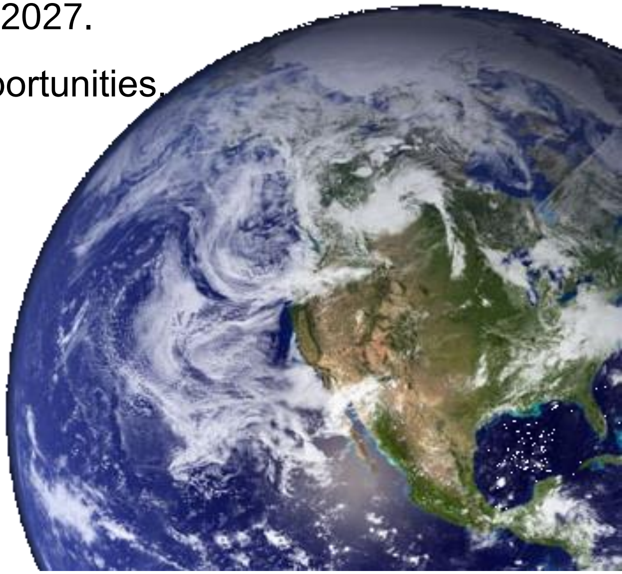
STM:

In ST, we create sustainable technology for a sustainable world, in a sustainable way. Sustainability has been embedded in our business model and culture for nearly three decades; and we are committed to become carbon neutral by 2027.

We design and build products, solutions, and ecosystems that address our customers’ challenges and opportunities, and the need to support a more sustainable world.

With our Sustainable Technology program, we take a holistic approach to make our operations and our products more sustainable through a comprehensive lifecycle approach.

For more information, read our latest Sustainability report [Link: https://sustainabilityreports.st.com/]



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Sustainability Efforts II

Bosch:

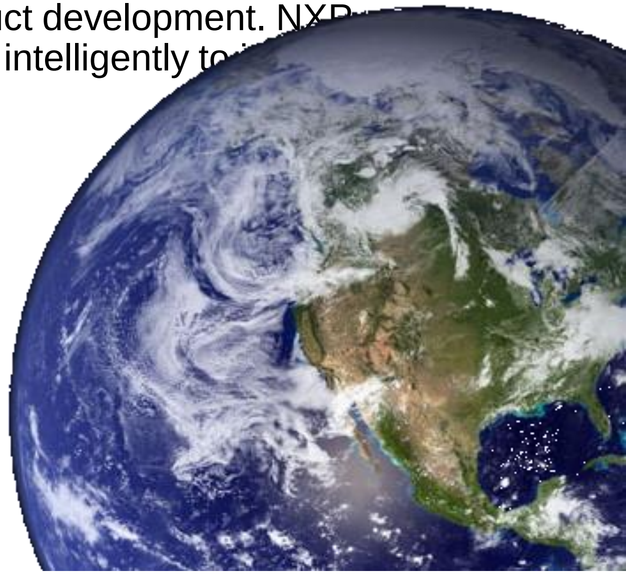
We firmly believe that sustainable, ecological, and socially responsible action is the foundation for our success in business. This attitude characterizes the entire company and is reflected in our actions at all levels. By acting in an economically, environmentally, and socially responsible manner, we want to improve people’s quality of life and safeguard the livelihoods of present and future generations.

NXP:

NXP Semiconductors enables a smarter, safer and more sustainable world through innovation. As a world leader in secure connectivity solutions for embedded applications, NXP is pushing boundaries in the automotive, industrial & IoT, mobile, and communication infrastructure markets. We are passionate about technology and believe it can be a powerful catalyst for change. We also recognize that advances in technology can bring with them new challenges for sustainability. For this reason, we make the principals of sustainability — such as energy efficiency, safety, and security — central to our work in product development. NXP designs purpose-built, rigorously-tested technologies that enable devices to sense, think, connect and act intelligently to people's daily lives.

Nexperia:

We are committed to provide a safe working environment, promote good health, minimize the environmental impact of our activities and protect the environment with our way of working and the products we develop. We foster innovations and creative solutions that add value for our customers, communities and our planet. We define Sustainability as part of our "Efficiency wins" strategy through the inclusion of environmental, health & safety, social and governance issues in our business strategy. Sustainability is part of everyday work of all employees worldwide, from the Executive Management Team to each single employee, from product development until disposal.



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DA5 Project at a Glance

- 04/2009: Decision to form DA5 consortium:
  STMicroelectronics, NXP Semiconductors, Infineon Technologies, Robert Bosch, and Freescale Semiconductors
- DA5 = **D**ie-**A**ttach **5**
- ELV Annex2, exemption 8(e) and RoHS 7(a) cover the use of lead in high melting temperatures type solders in various applications
- DA5 focus on the use of high melting solder in semiconductor applications, especially for die attach in power packages
- 12/2015: NXP and Freescale merge into NXP
- 07/2017: nexperia joined the DA5 consortium
- 07/2017: Members of DA5 consortium:

DA5 Approach
Press Release (Q2/2010) at start of DA5 project

Bosch (Division Automotive Electronics), Freescale Semiconductor, Infineon Technologies, NXP Semiconductors and STMicroelectronics today announced that they have formed a consortium to jointly investigate and standardize the acceptance of alternatives for high-lead solder for attaching dies to semiconductor packages during manufacturing. The five company consortium is known as the DA5 (Die-Attach 5).

Implementation and availability

For environmental reasons, the semiconductor industry is making every effort to eliminate high-lead solder, where feasible. However, there is no single identified lead-free solution for all applications and there is no expectation of a substitute for a high-lead solder die attach before 2014. Any solution will require substitute material development and evaluation, internal semiconductor process and product qualification, and semiconductor production conversion to guarantee product reliability.

By jointly developing and qualifying an alternative, the DA5 consortium aims to reduce the qualification time needed by its customers and provide lead-free and environmentally friendly solutions as quickly as possible.

The consortium approach

A previous joint effort known as the E4 (IFX, STM, NXP, Freescale) successfully implemented more environmentally friendly materials for semiconductor packages. Lead-free high melting temperature die attach was not in the scope of the E4 effort since this solder material was exempted from the 2006 EU RoHS Directive.

The announced DA5 consortium aims to reinitiate the earlier E4 cooperation and use the proven formula for success to lead the industry into the next phase of the lead-free semiconductor evolution. In this way the DA5 companies are also actively supporting the demands of the European Union towards reduced lead in electronics.

Lead in semiconductor products

Semiconductor products use high-lead containing solder for a die attach material in power devices, in diodes and transistors, for clip bonding of discrete devices and for surface mount and insertion components. Many of these devices have an essential safety purpose in automotive applications. The unique properties, such as the high melting point and thermal conductivity of these high-lead alloys, are necessary for the level of reliability required for these products.

Currently, there is no proven alternative for these high-lead die attach solders. Therefore, the DA5 consortium companies are soliciting input from die attach material suppliers to jointly evaluate and develop possible alternatives. This approach is expected to speed up implementation and customer acceptance of the environmentally friendly materials.

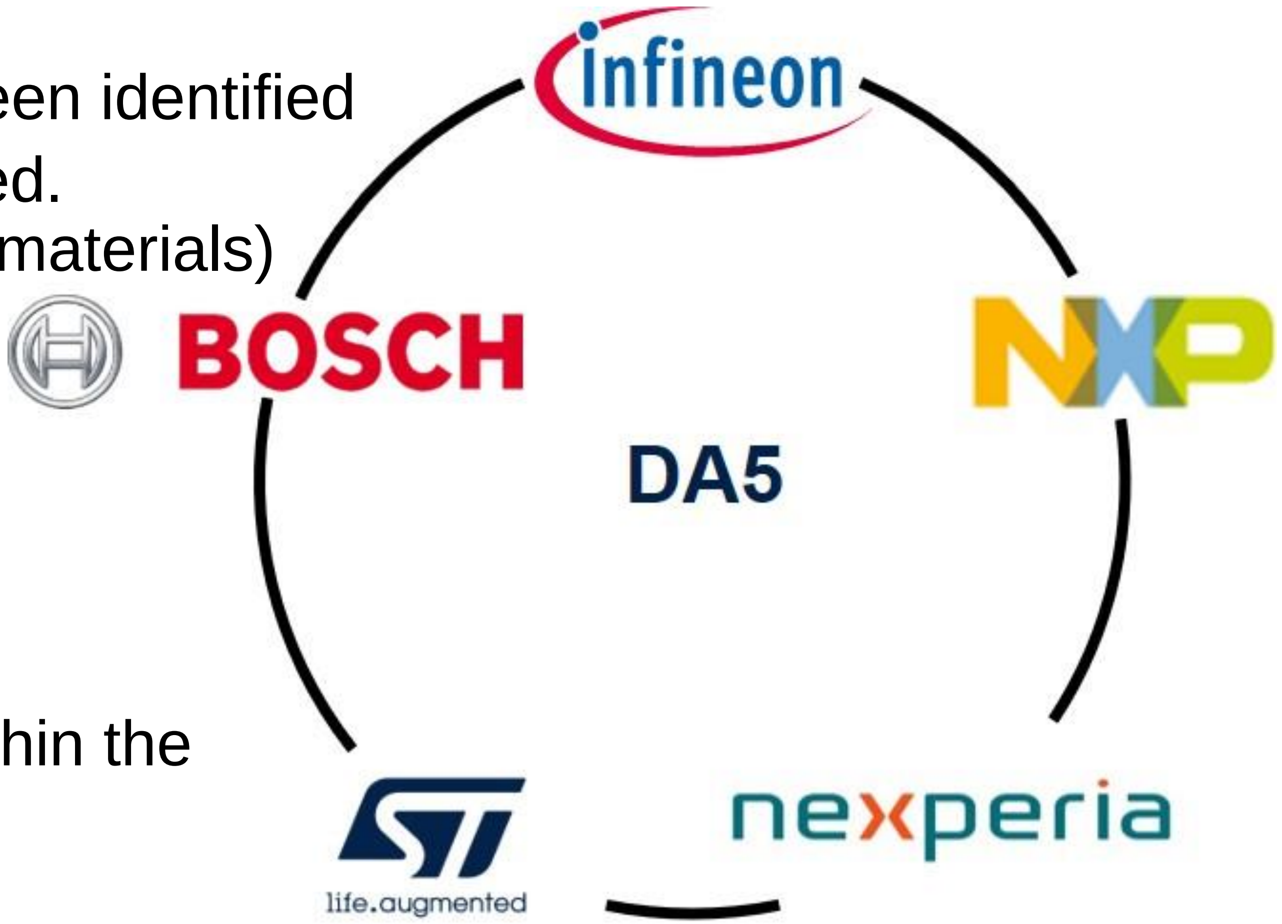
DA5 Project Objectives

- Joint development by semiconductor suppliers to address and **mutually define** the direction of Pb-free solder die-attach technology
- DA5 is working together with material suppliers to find feasible alternative solutions for lead-free die-attach
  - Evaluate available and potential alternatives
  - Prioritize the evaluation of potential material candidates
- General requirements like reliability and processing of die-attach materials are collected in the **“DA5 Die-Attach Material Requirements”** document which is available upon request at DA5
- Lead-free solutions have to fulfill those in the same way as leaded solutions do already
- Target:
  Identification of **sustainable, robust, standardized, reliable and dependable solutions for our customers**

Slide updated

DA5 Setup for Pb-free Die-Attach

- Major material suppliers from Europe, US and Asia were assessed
- 21 major material suppliers have been identified
  - Continuous contact is established.
    (some stopped to offer relevant materials)
  - DA5 is continuously looking for further suppliers offering suitable materials
- 5 material suppliers are working continuously with DA5
  - To develop specific solutions within the DA5 project work packages

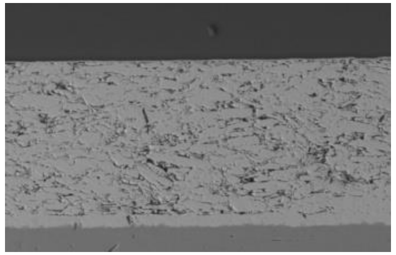


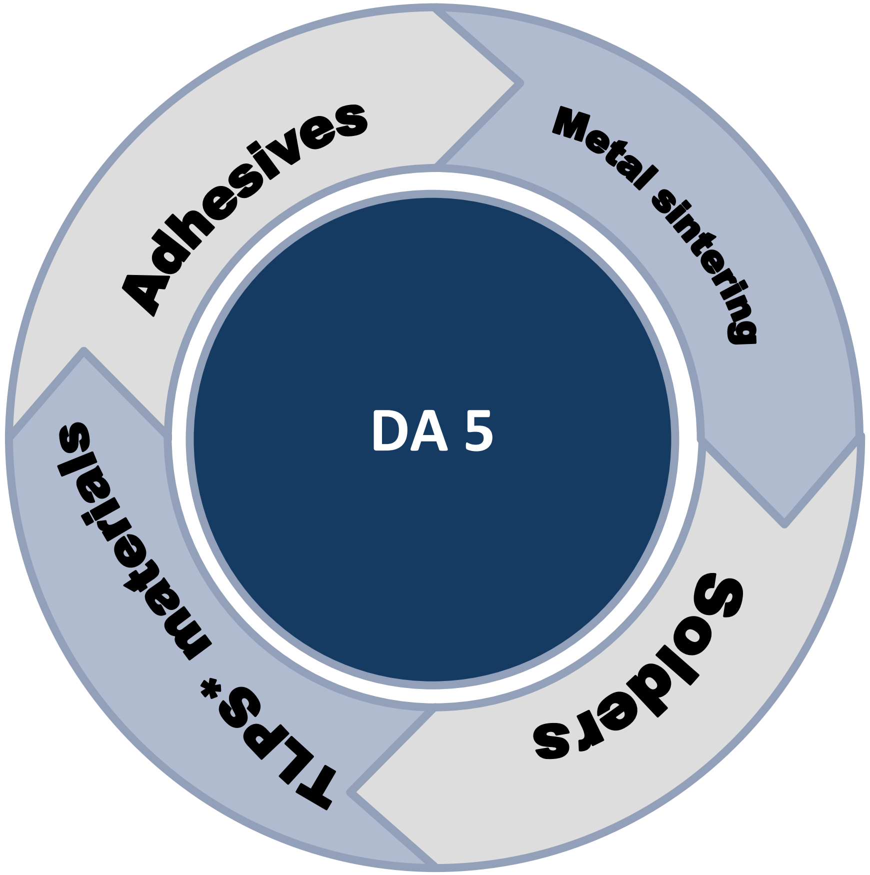
Challenges/ Requirements

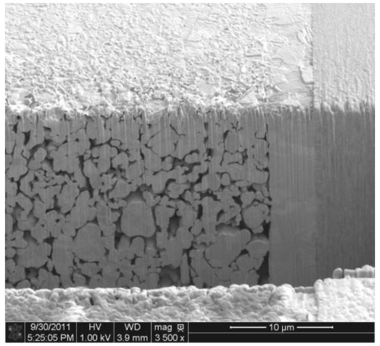
- Potential die-attach materials have to withstand the 260°C temperature during second level soldering on PCBs (no re-melting or delamination after 3 times reflow)
- Potential die-attach materials have to support
  - Thin die usage (thickness < 120µm, fillet height control)
  - Large die usage (die size up to 70mm^2, low void level)
  - Reliability requirements (e.g. AEC-Q-100/ AEC-Q-101)
  - Several lead frame/ chip backside metallization (e.g. Cu, Ag, Ni)
  - Comparable or better thermal and electrical conductivity as lead based solder
  - Stress buffer for CTE differences between die and lead frame
- Excellent workability characteristics (dispense and printing)
- Compatible with clip bonding
  - Top of die material coverage (manage source and gate size differences)
  - Prevent shorting of source and gate (no flow or bleed of material)
  - Withstand forces during processing, e.g. in molding and trim & form
- A detailed requirement list can be found in the document: **“DA5 Die-Attach Material Requirements”**

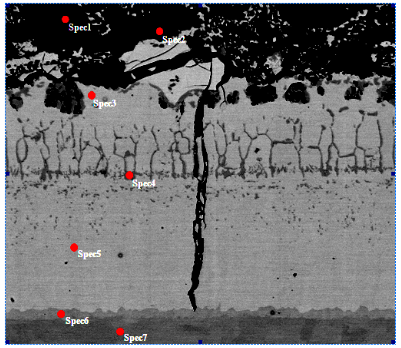
Materials

- 4 different material "classes" are evaluated





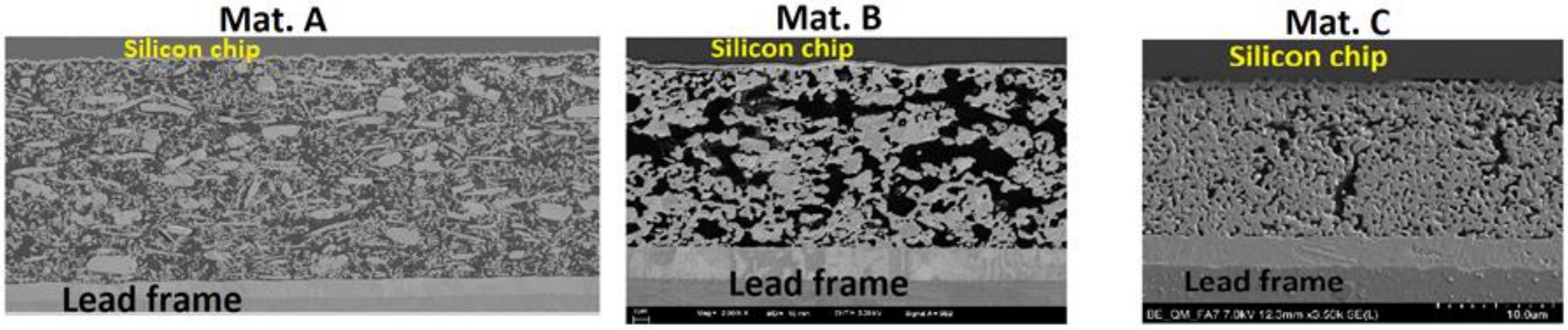




* Transient Liquid Phase Sintering

Conductive Adhesives I

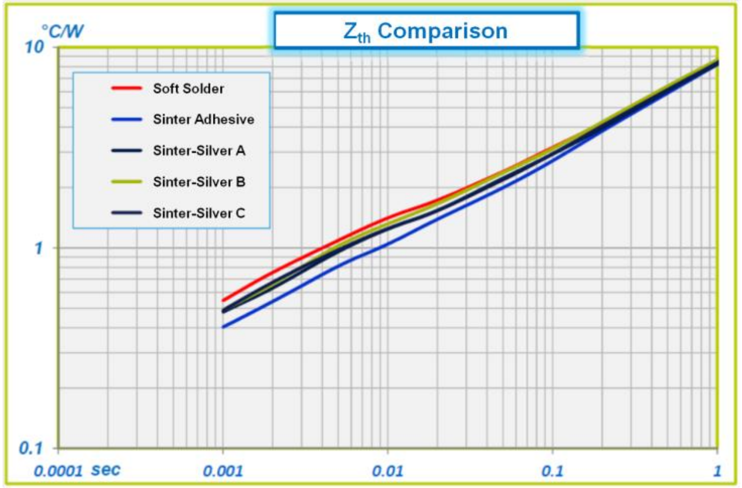
- **Principle**
  - High electrical and thermal conductivity of adhesives is achieved by an increased silver filler content with very dense packing of filler particles. Reduction of particle size to micro and nanoscale stimulates a sintering of the silver particles during the resin cure process
  - The remaining resin content is a key factor determining the physical properties of the material. The transition from an adhesive with very low resin content to a pure Ag-sinter material is gradual
  - Hybrid adhesive/ sinter materials combine the advantages of a silver filled adhesive (thermal-mechanical stability, low sensitivity to surfaces) with the high conductivity of a sintered Ag material



Increasing sintering levels, conductivity, and elastic modulus

Conductive Adhesives II

- **Advantages**
  - Organic resin improves adhesion to different types of chip backside metals and lead frame platings
  - Same or better mechanical, thermal, and electrical properties compared to solder, similar to sintered silver. Commonly used die bond equipment can be used for dispensing, chip placement, and curing of the material (drop-in solution)
  - Can pass automotive environment stress test conditions (AEC-Q100, AEC-Q101) depending on package type and die size

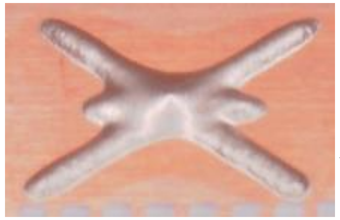


Comparison of transient thermal resistance of highly silver filled adhesive vs. high-lead soft solder and sintered silver materials

Scanning acoustic microscopy shows no delamination of die attach after 2000 cycles TC -50°C / +150°C

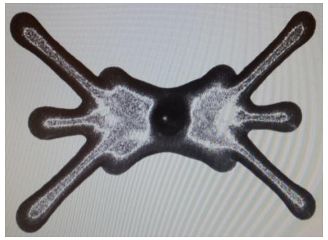
Conductive Adhesives III

- **Limitations**
  - Materials contain solvents to improve rheology for dispensing. This requires careful handling and control of the manufacturing process. It also bears a risk of lead frame and die surface contamination
  - Material cost is higher compared to standard adhesives and solder alloy
  - Process window (bond line thickness, curing conditions) has to be determined for every die size
  - Maximum die size (~50mm²) strongly depends on package design and materials. Backside metal is required
  - Materials with sintered structure have high elastic modulus causing mechanical stresses and higher delamination risk
  - Limitation seen for high power devices and moisture sensitivity level greater than MSL3/ 260°C
  - Material usage only possible for die thickness >120µm for the moment

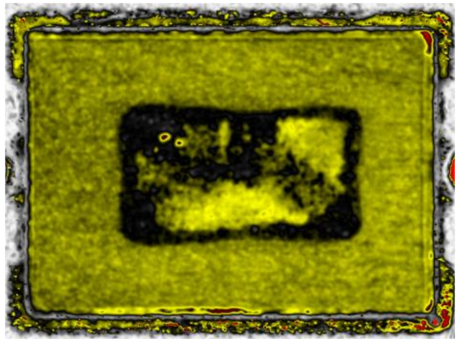


Dispense Patterns

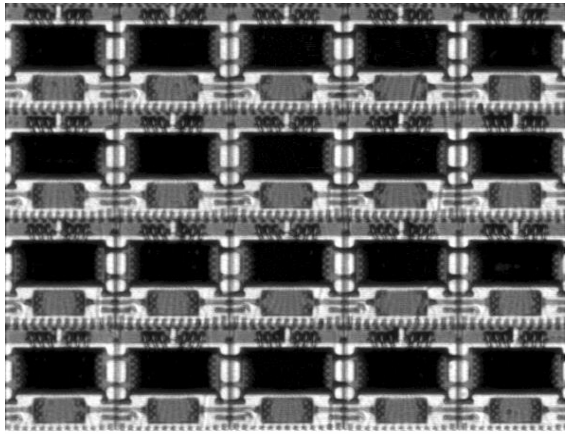
Visible solvent bleed out



No solvent bleed out



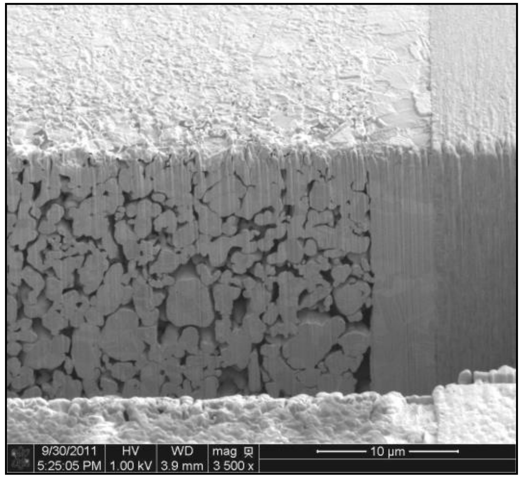
Scanning acoustic microscopy of an as-cured good part: apparent inhomogeneity detected



Scanning acoustic microscopy shows delamination of large power transistor die attach after 1000 cycles TC -50°C / +150°C

Metal Sintering I – Overview

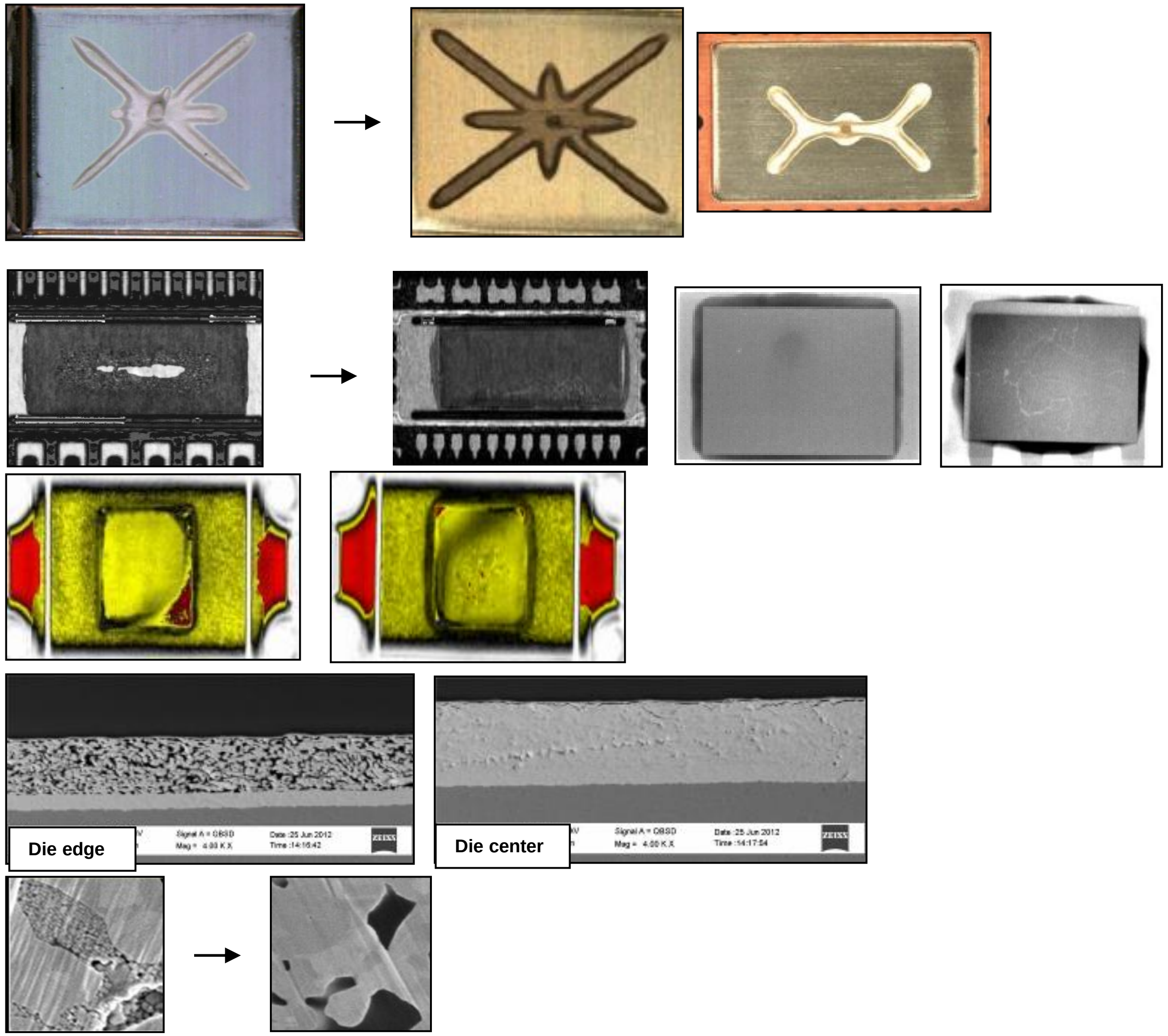
- **Principle**
  - Ag- or Cu-sintering pastes: Ag or Cu particles (µm- and/or nm-scale) with organic coating, dispersants, & sintering promoters
  - Dispense, pick & place die, pressure-less sintering under N_2 or air inside box oven
  - Resulting die-attach layer is a porous network of pure, sintered Ag or Cu



- **Advantages**
  - Significantly better thermal and electrical performances than Pb-solder become possible
- **Disadvantages**
  - No self-alignment as with solder wetting
  - nm-scale metal particles are at risk of being banned
  - New concept in molded packaging - no prior knowledge of feasibility, reliability or physics of failure
  - Production equipment changes might be needed (low-O_2 ovens, sintering presses)
- **Main risks**
  - Limitations found in die area/thickness, lead frame & die finishes
  - Potential reliability issues: die crack, breaks inside bondline, delamination or die lift, organic contamination, thickness reduction due to continued sintering, interface degradation or electromigration of Ag (O_2 or humidity penetration, un-sintered Ag particles in die-attach layer)

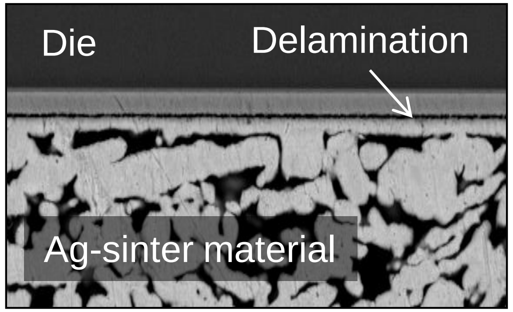
Metal Sintering II – Assembly

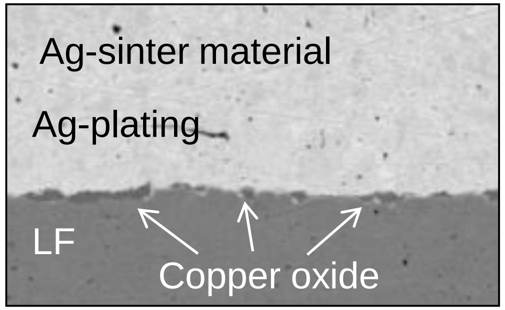
- Dispensability and staging time are improving, long run workability data not available
- Voiding is improving
- Process control issue: C-SAM scans are difficult to interpret
- Bond line density differences should be improved
- Reduction of un-sintered Ag particles is improving

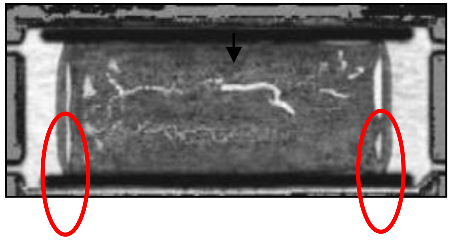


Metal Sintering III – 0-hr & Reliability Results

- Oxidation and/ or delamination of interfaces is common, even before reliability testing, lowering adhesion and electrical & thermal performance. Potential solutions (not yet proven):
  - Reduce oxygen content in atmosphere during sintering
  - Change paste formulation to allow for lower sintering temperature or less interaction with back-side metallization
  - Change back-side metallization
- In cases with no delamination, high DSS (20 N/mm^2) and good thermal performance can be obtained with Ag plating
  - In-package electrical performance still worse than of Pb-solder
- No test configuration has passed yet all required reliability tests after MSL1 preconditioning
  - Results after MSL3 preconditioning are better, with reduced cracking and delamination
  - Recent results show further improvements, but:
    - still some delamination after temperature cycling and pressure pot/ autoclave tests
    - failures during biased tests (THB, HAST) are common
- High risk of Cu particle oxidation during sintering, which can degrade electrical and thermal perfomance
- Physics of failure understanding missing/ ongoing: already porosity and bond line thickness changes were observed
  - Die penetration test shows non-hermetic die attach (at least for ~1mm from the edges of the die), which can be a significant quality risk for moisture penetration from ambient, leading to package/ die crack during PCB reflow (commonly known as pop-corn effect)

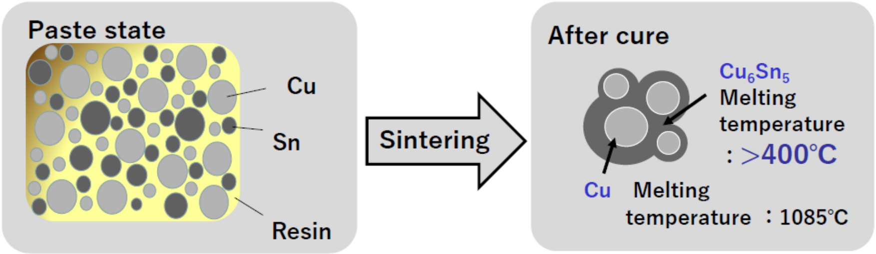


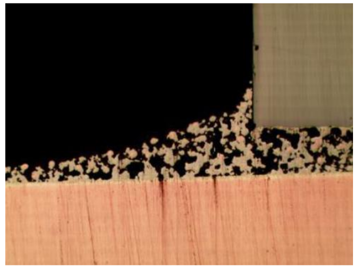




TLPS materials I

- **Principle of Transient Liquid Phase Sintering (TLPS)**
  - TLPS paste in general is a mixture of a high melting metal powder (for example Cu or Ag) and a Pb-free solder powder (for example Sn based) in an organic flux
  - After curing a matrix of pure Cu, CuSn alloy (melting temp. > 400°C) and resin is formed

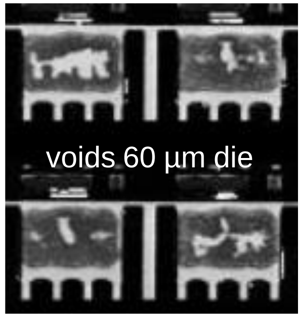


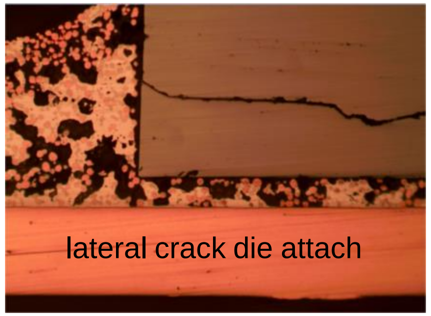


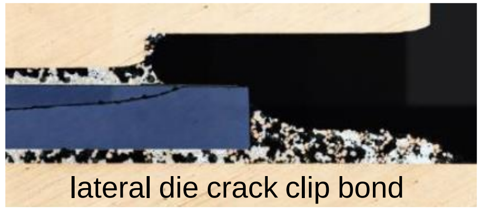
- **Advantages**
  - In principle compatible with existing assembly methods like dispense and stencil printing, sintering is possible in a reflow oven or batch oven
  - Better cost position compared to (hybrid) Ag sintering solutions
- **Disadvantages**
  - Relatively new concept in molded packaging, limited knowledge of feasibility or reliability
  - Not compatible with thin die
  - High modulus (stiffness) and high CTE induce die stresses
  - Thermal and electrical performance are in the range of Pb solder, but large differences between various versions

TLPS materials II

- **Quality & Reliability Risks**
  - Risk of overflow on top of die in clip bonding causing shorts between gate and source
  - High risk of Cu oxidation if oxygen concentration exceeds 300ppm during sintering under nitrogen
  - Delamination and die crack risk (for larger die sizes) due to high modulus and high CTE
  - Potential Kirkendall voiding during IMC growth, e.g. in HTS at 175°C (high temp. storage)
- **Observations**
  - High dispense pressure needed compared to common practice
  - Fillet height and void rate too high for thin die
  - The reflow profile is critical and appears to be product dependent
  - Results are package or lead frame material dependent
  - Strong brittle intermetallic phase growth with Cu
  - Lateral die cracks after curing and in thermal cycling
  - Some suppliers stopped their TLPS material development
- **Material Status**
  - At the current development stage TLPS is not a reliable alternative for high Pb solder for die attach and clip attach







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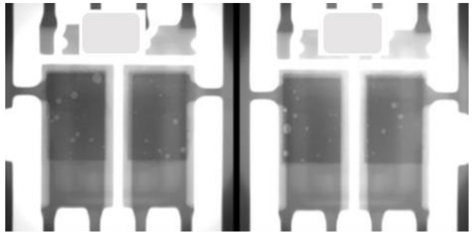
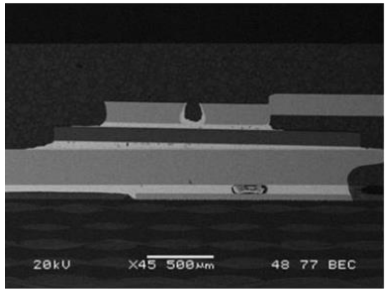
Alternative Solders I

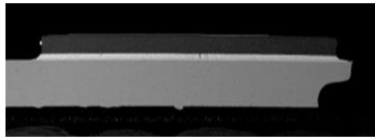
Properties to be considered

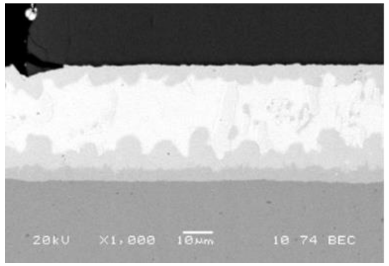
- Robust manufacturing process
  - Repeatable solder application
  - Stable wetting angle
  - Surface compatibility (chip backside, LF finish)

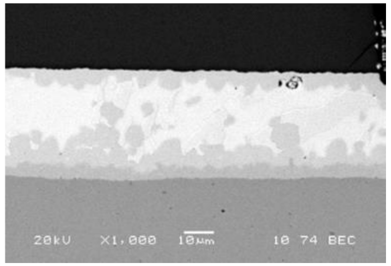
- Reliability
  - Voiding / cracking / disruption after stress
  - Growth of brittle intermetallics at high temperature
  - Disruption during temperature cycling









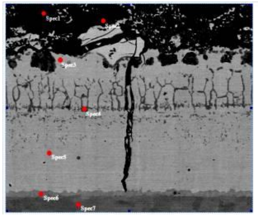


Slide updated

Alternative Solders II

- Zn-based Alloys
  - Material currently only available in wire form
  - Low wettability makes the use of special equipment necessary (capability for mass production open)
  - Process temperature very high (above 410°C) => high risk for incompatibility with chip technologies
  - Growth of brittle intermetallics at high temperature limits reliability
  - New formulations demonstrate lower mechanical stress and reduced die cracking.
  - Improved reliability expected for die < $10mm^2$ in combination with a new experimental lead frame surface
  - Risk of Zn re-deposition can only be assessed in high-volume manufacturing
- Bi-based Alloys
  - Low thermal conductivity & low melting point
  - Performance minor to high lead solder → no replacement option
- SnSb-based Alloys
  - New formulations with improved melting point available
  - Workability to be improved (voiding, die cracking)
  - Limited surface compatibility (chip backside, LF finish)
  - Secondary reflow and reliability not yet demonstrated
  - Materials are offered in paste and as pre-form

Low wettability (SAM pictures)



Brittle Zn intermetallics

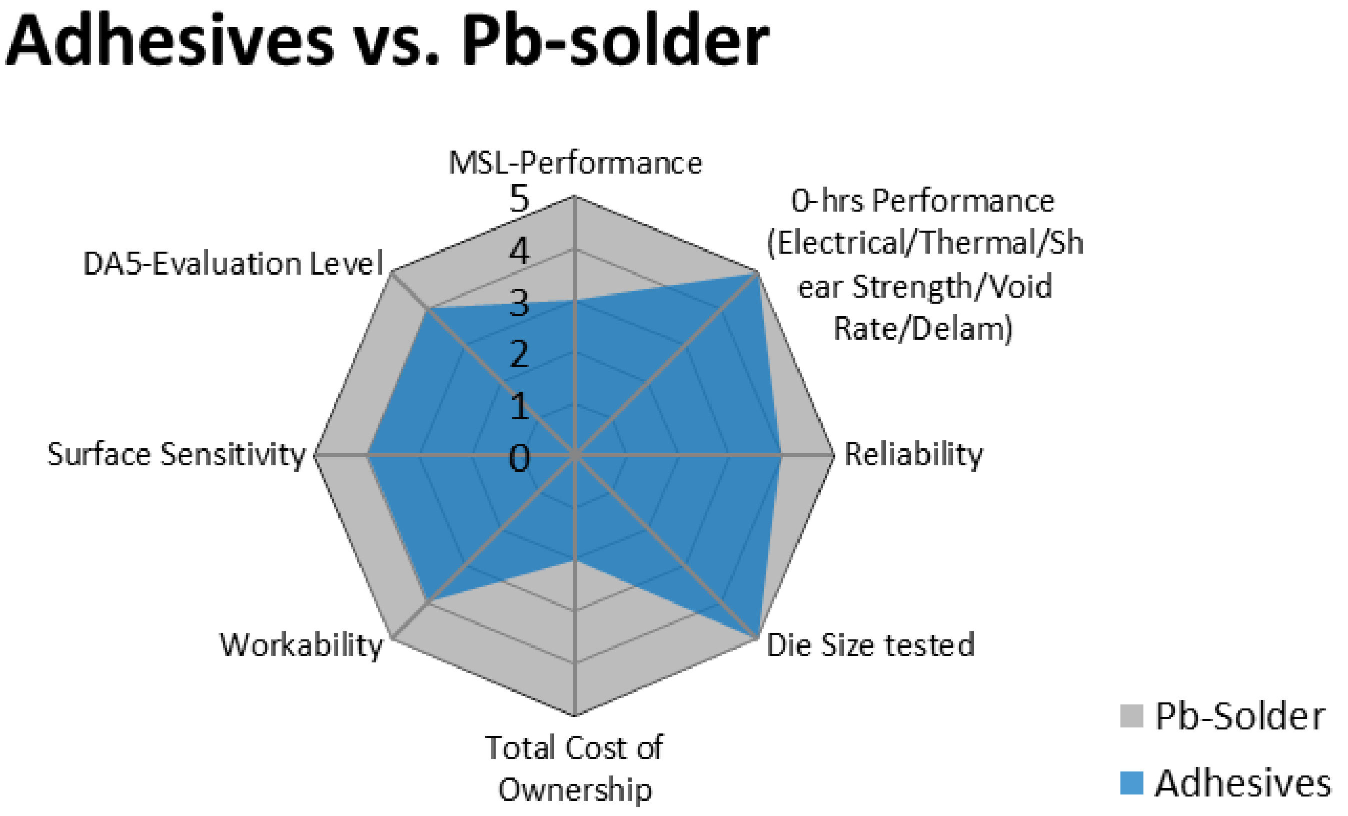
Slide updated

Alternative Solders III

- SAC-SnSb mixed Alloys
  - Workability to be improved (voiding)
  - Surface compatibility to different chip metallizations to be proven
  - Good reliability performance
  - Materials are offered in paste

Key Performance Indicators I

- Comparison of competing Technologies



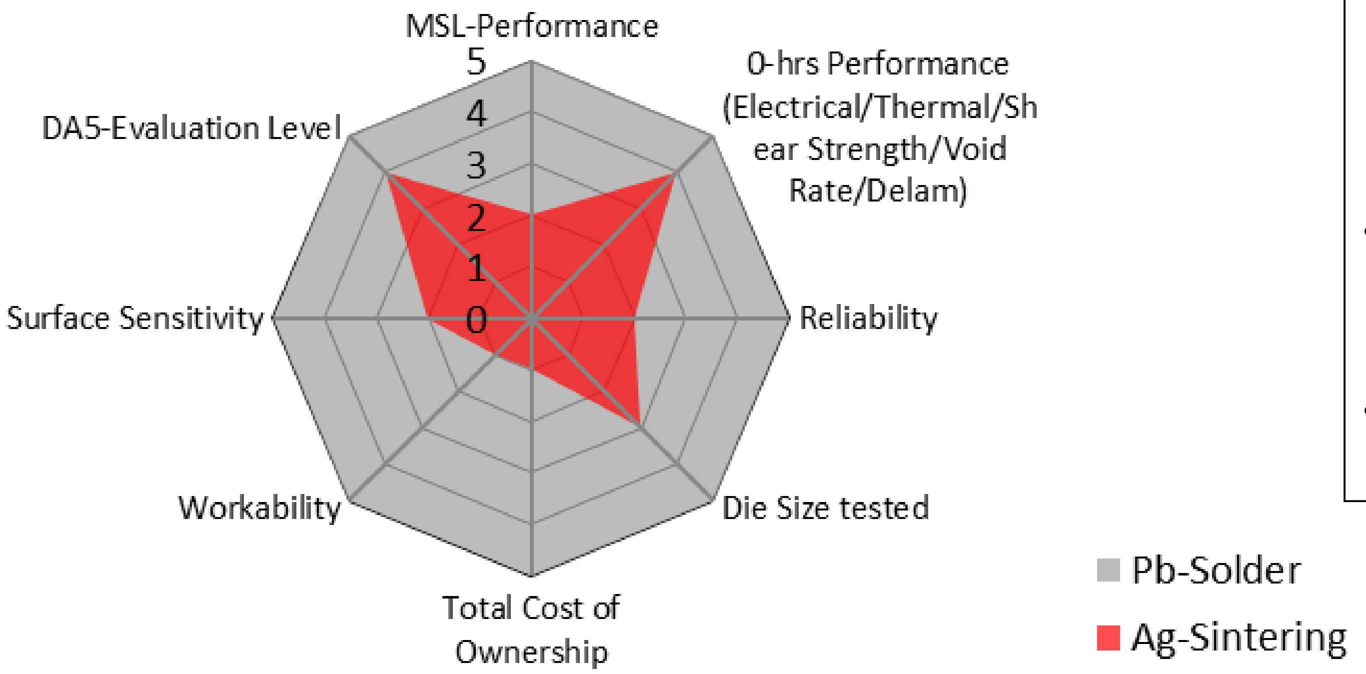
(rating: 0 unknown, 1 very poor, 2 poor, 3 fair, 4 good, 5 very good: as good as Pb-solder)

- DA5 now uses a new rating system with revised criteria (Pb-based solder reference set to 5 for all criteria) for the technology comparison
- DA5 assessment refers to the best material tested in its class
- DA5 assessment only valid for die thickness > 120µm

Key Performance Indicators II

- Comparison of competing Technologies

Ag Sintering vs. Pb-solder



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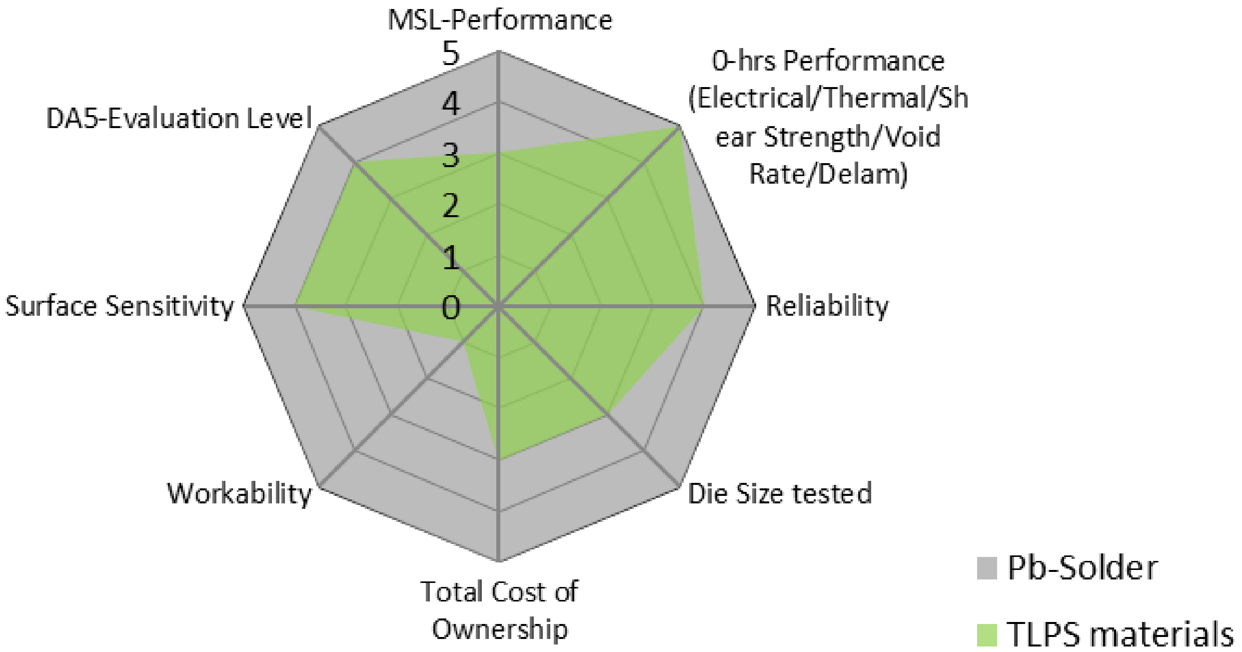
Key Performance Indicators III

- Comparison of competing Technologies

TLPS materials vs. Pb-solder



(rating: 0 unknown, 1 very poor, 2 poor, 3 fair, 4 good, 5 very good: as good as Pb-solder)

- DA5 now uses a new rating system with revised criteria (Pb-based solder reference set to 5 for all criteria) for the technology comparison
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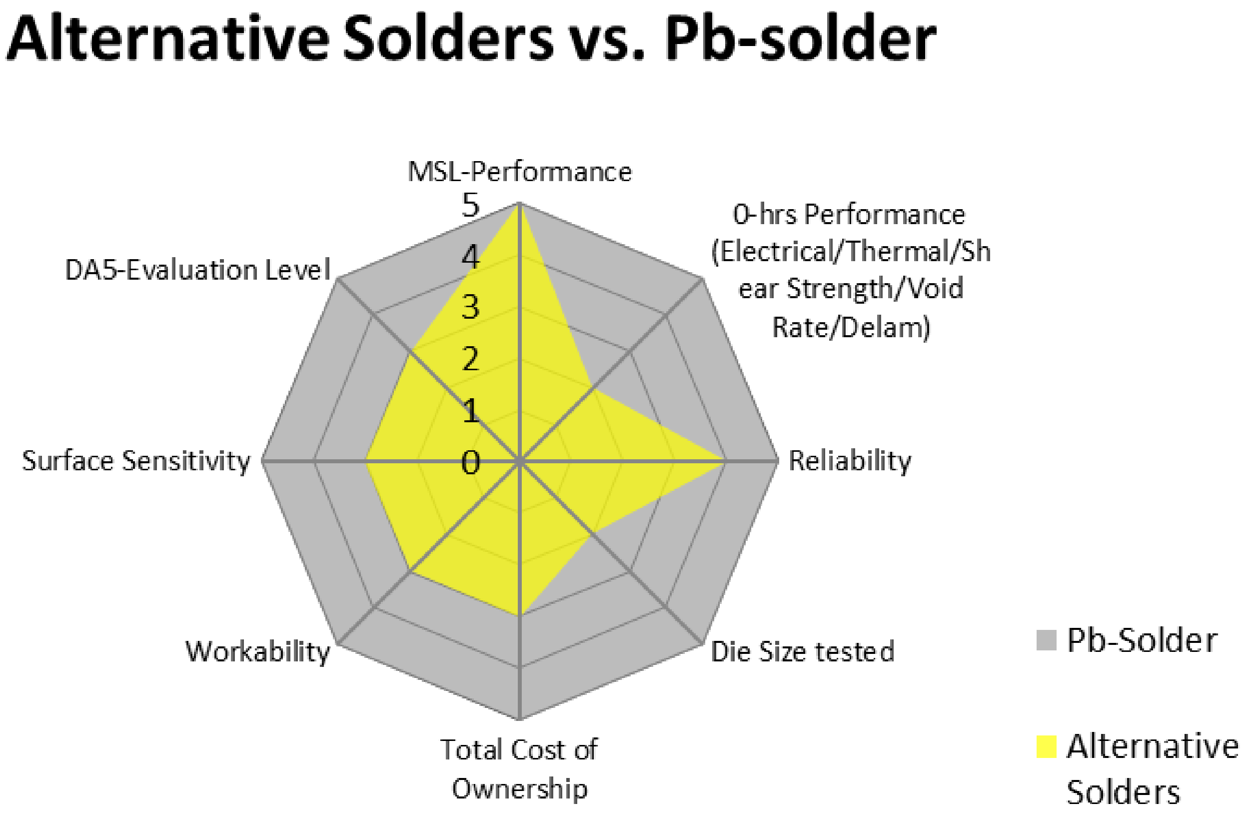
- DA5 assessment only valid for die thickness > 120µm

Slide updated

Key Performance Indicators IV

- Comparison of competing Technologies



(rating: 0 unknown, 1 very poor, 2 poor, 3 fair, 4 good, 5 very good: as good as Pb-solder)

- DA5 now uses a new rating system with revised criteria (Pb-based solder reference set to 5 for all criteria) for the technology comparison
- DA5 assessment refers to the best material tested in its class
- DA5 assessment only valid for die thickness > 120µm

Agenda

- Motivation: Environmental and health endangerment by lead
- Status on legislation
- Situation: Lead & the use in Electronics
- DA5 Structure and Project:
  - Sustainability Efforts
  - Cooperations and partners
  - Requirements, Applications and Approaches for possible solutions
  - Results
- **Timeline and Conclusion**

Slide updated

Timeline

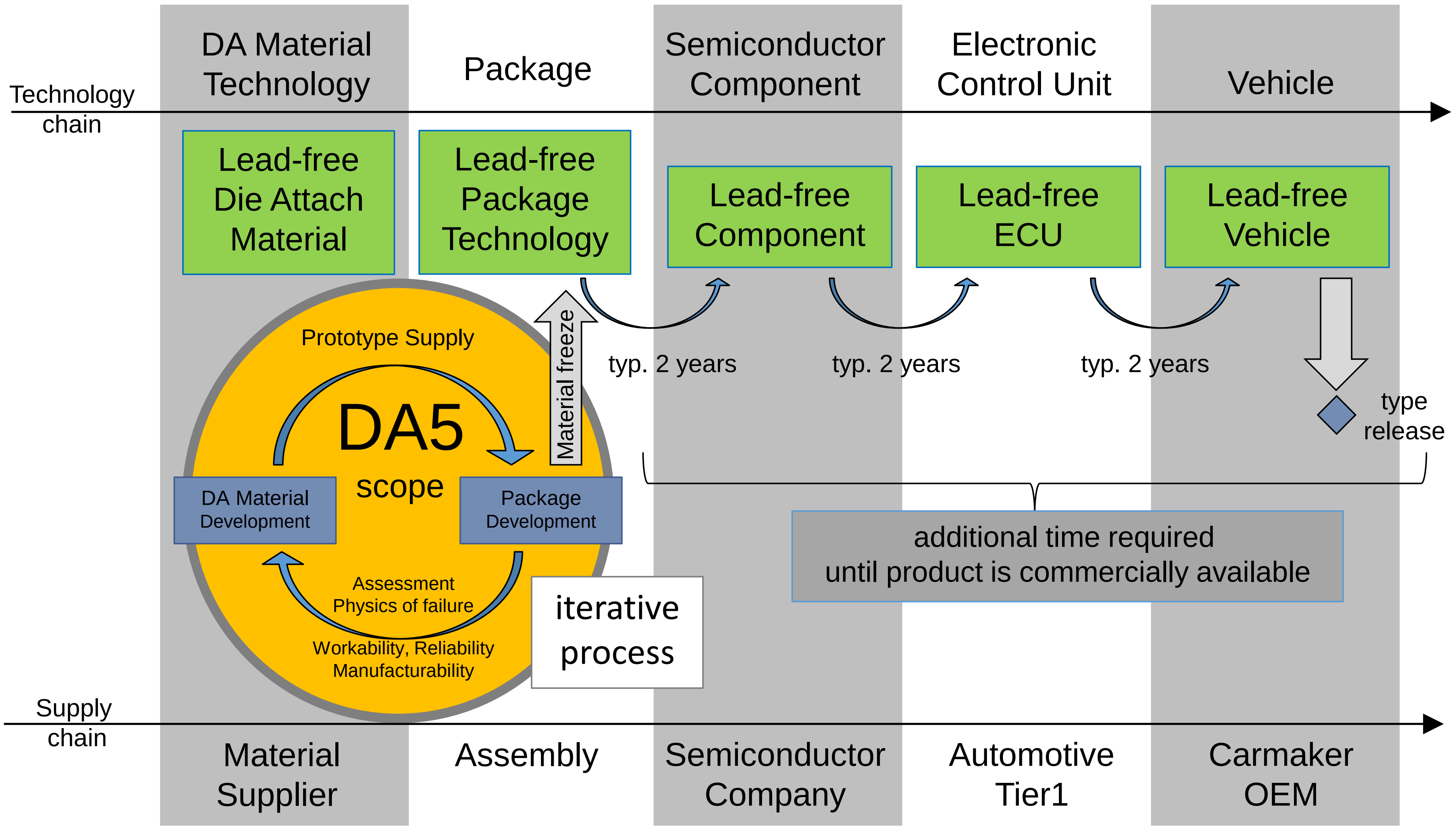
- DA5 meets the selected material supplier three times a year for a common update of the latest material evaluation results
- In between alignment meetings between the material supplier and the DA5 work package leader (one DA5 company per selected material supplier) take place
- Last DA5-supplier workshop took place as face-to-face meeting in July 2022
- Next DA5-supplier workshop planned in November 2022

Slide updated

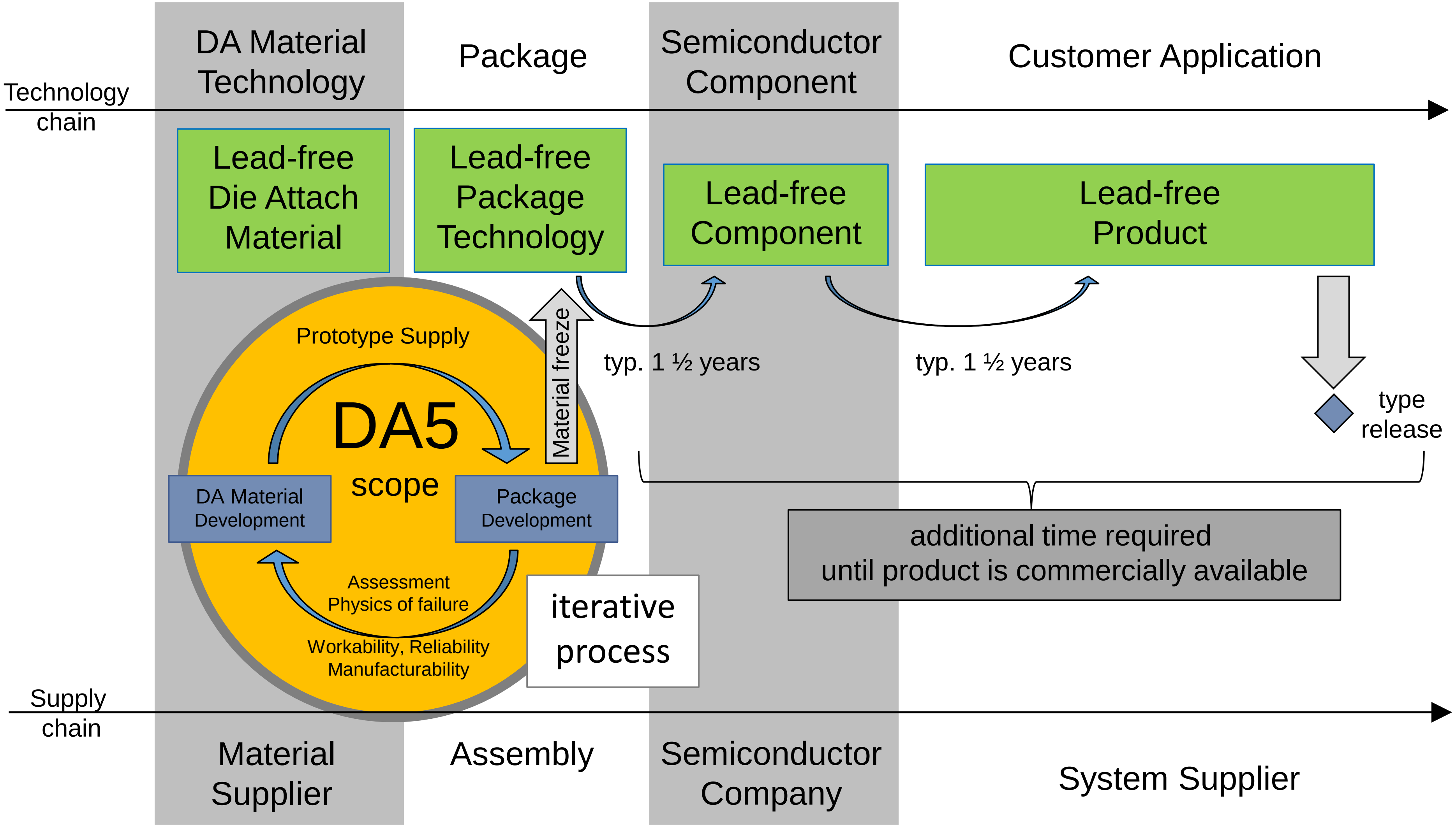
Summary DA5-supplier workshop Jul 2022

- Several suppliers presented their latest activities on Pb replacement for die attach materials
  - The results have been discussed thoroughly during the meeting
  - DA5 provided detailed feedback related to the presented materials
- Two new material candidates have been introduced by the material suppliers; one completely new material
- Up to now, none of the proposed materials fulfills the requirements for a Pb free die-attach material as defined in the DA5 material requirement specification
- The next DA5-supplier workshop will be in November 2022

DA5 - Automotive Release Process(ELV)



DA5 - Industrial Release Process(RoHS)



Slide updated

Conclusion I

- Today's lead-free material technologies for semiconductor applications (die attach) are not ready to substitute **L**eaded **H**igh **M**elting **T**emperature **S**olders
- **Substantial development efforts have been running for more than 12 years.
More than 150 materials from more than 14 suppliers were evaluated. Close to 50 of those materials were selected for extensive testing by DA5 member companies.
Although some promising results were identified in specific applications, none of the materials proved suitable as a general Pb-replacement solution.
While the DA5 consortium has not yet found a reliable lead-free package technology for power semiconductor components, the research is promising for long-term solutions**
- Material evaluations continue in close cooperation with material suppliers, but semiconductor component qualifications, material supplier conversions and equipment conversions can only begin after a reliable lead-free package technology for replacement is available

Slide updated

Conclusion II

- **Customer qualifications (TIER1 and OEM) and supply chain conversion/ ramp up can only begin after package technology and semiconductor component qualification**
- No fit for all lead-free solution is in sight! Different applications will need different solutions
- The DA5 consortium expects that in the next decade more and more devices using newly available lead-free materials will enter the market for limited applications
- Moreover, availability of lead-free materials for the entire semiconductor components portfolio cannot be anticipated
- Based on current status, DA5 supports the continuation of the lead exemptions under RoHS and ELV EU Directives (and equivalent WW legislations)
- **Once a solution is identified and the material frozen, per slides 38/ 39, lead free materials widespread deployment on generic application will be possible**

List of Abbreviations

Ag	Silver	DSS	Die Shear Strength	MSL	Moisture Sensitivity Level	RoHS	Restriction of Hazardous Substances
Au	Gold	ELV	End-of-Life Vehicle	N_2	Nitrogen	Sb	Antimony
Bi	Bismuth	EU	European Union	Ni	Nickel	Sn	Tin
C-SAM	Scanning Acoustic Microscopy	EU COMM	European Union Commission	O_2	Oxygen	TC	Thermal Cycles
CO_2	Carbon Dioxide	HTS	High Temperature Storage	OEM	Original Equipment Manufacturer	TLPS	Transient Liquid Phase Sintering
CTE	Coefficient of Thermal Expansion	IMC	Intermetallic Compound	Pb	Lead	Zn	Zinc
Cu	Copper	In	Indium	PCB	Printed Circuit Board		
DA5	Die-Attach 5	LHMTS	lead in high melting temperature type solders	ppm	parts per million		

Contact Information

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DA5 customer presentation:
http://www.infineon.com/da5customerpresentation

The full specification document “DA5 Die-Attach Material Requirement Specification” is available upon request at DA5, see contact above