MicroTech 21 Online – Heterogeneous Integration – Packaging Future Microsystems

25th March 2021

The IMAPS-UK organised MicroTech 21 Online Conference on Heterogeneous Integration explored many aspects of Heterogeneous Integration covering packaging developments for ICs, power modules and photonics, materials, processes and including wider considerations of sustainability, equality, diversity and inclusivity within the electronics industry.

The Conference Chair, Andy Longford (PandA Europe) welcomed participants to the on-line event with a short video advertising the event and a formal Powerpoint introduction to IMAPS-UK. A welcome from Scott Wood of Accelonix, one of the event sponsors, included a short video. The chair (AL) then showed a video explaining the Company Showcase, before introducing the 1st Keynote Speaker, William (Bill) Chen from ASE Group. ASE were also a sponsor of the event.

Session 1: Keynote Presentation – The Future is Heterogeneous Integration – William Chen – ASE Group

The keynote presentation from William Chen of ASE Group indicated that HI is now the way that packaging is going to develop. Tech companies are now the key drivers of financial; markets whereas ten years ago it was oil companies. Data is the new "oil". The presentation showed examples of the latest consumer packaging applications and how what was homogeneous integration has now transformed to Heterogeneous integration with the new developments of chiplets. Advanced Packaging integration and the "SiP module toolbag " is now available for a wide range of applications including AI, 5G and IoT. There are quite a number of advanced package varieties showing how developing package technology is necessary to meet application and market needs. Complexity and cost are driving the developments in HI. In the USA DARPA have launched the Electronics Resurgence Initiative (ERI) to further drive HI and create a convergence of the chip and system developments. The presentation concluded with remarks from key Industry leaders supporting HI development.

Session 2: Advanced Packaging Developments

Heterogeneous Integration of Power Modules – Geoff Haynes - RAM Innovations

Geoff Haynes introduced RAM Innovations, a UK company pioneering embedded package technologies. The application for Power packaging was presented and the use of GaN and SiC devices was reviewed. GH demonstrated that the capability to embed such chips in an embedded form of package will have both cost and performance advantages. An example of a GaN based half bridge module design was detailed. Further developments showed the aspects of adapting the package technology to further integrate aspects such as fluid cooling and additional circuitry.

Questions were raised on the sinter materials used in the assembly of power modules, embedding of capacitors and inductors within the modules.

Hybrid Integration for Advanced Photonics Packaging – Jay Chandrappan – CSA Catapult

Jay Chandrappan of the CSA Catapult presented a review of how photonics packaging is integrating the optical and electronic requirements to create complex photonic sub system modules. The interconnection aspects of Photonics were explained and the impact of new Compound Semiconductor (CS) devices in photonic applications was detailed. The packaging processes were detailed and several challenges were identified. JC put forward some techniques that are now being developed to introduce Hybrid Integration into photonics including the use of Silicon platforms. The concept of 3D additive nanofabrication was presented to show the expected next generation solutions for interconnection. The CSAC is supporting the developments with advanced design tools and state of the art equipment within the Newport facility.

Questions included:

How much does shrinkage of encapsulants affect the alignment tolerances for photonics assembly?

For embedded waveguides and flip-chip bonding are you using underfills?

For co-design (Electrical, Thermal, Mechanical). Is the issue accurate optical analysis?

Session 3: Materials

Enabling Silver Sintering Developments for EMI shielding and Wire Bond Replacement – Ruud de Wit – Henkel

Ruud De Wit presented the use of silver sintering materials as EMI shields and as their use as an alternative to traditional wire bonds. The presentation began with examples of 5G mobile applications and showed packaging examples with 5G mm wave antennas. Advanced packaging solutions were presented and compared board level to package level shielding. Shielding with silver sintering materials was discussed with a process explanation on the use of lasers to create cavity walls and the spray application of silver materials to create the EMI shield. Printed silver interconnects were presented as an alternative to traditional wire bonds and highlighted the benefits of reduced electrical resistance and RF inductance.

Future Adhesives and SVHC – Eamonn Redmond, Inseto

Eamonn Redmond presented an overview of encapsulation and discussed the time/cost/process considerations involved in decisions between 'Glob Top' and 'Dam & Fill' approaches. REACH was explained and the impact and applicability to the UK post Brexit. Current and new materials were presented and their REACH compliance and performance compared. Possible legislation within the EU about Substances of Very High Concern (SVHC) may mean that some common encapsulants will be banned in the future and work is ongoing to introduce SVHC free materials to the market.

Session 4: Processes

Transfer moulding as part of the HI Chain - Sebastiaan Kersjes - BESI

Sebastiaan's presentation discussed the technologies involved in transfer moulding and in achieving the next generation of HI moulded packages primarily for Power applications. He shared how foil, thickness compensation and dynamic clamping can all be used to achieve advances in packaging technology. He explained the need for new epoxy moulding compounds and their characterisation.

A question was asked on substrate alignment within mould tool.

Wafer Level Processes for HI - David Butler - SPTS

David Butler presented the impressive developments in plasma technology supporting HI. Examples of direct face-to-face hybrid bonding and plasma dicing were shown and their implications for the higher density integration demands of next generation packaging explained.

Questions were asked on whether wafers needed to be redesigned to accommodate plasma dicing and what are the sources of Hydrogen responsible for the outgassing issues discussed.

Session 5: Technology R&D

3 presenters participated in the Packaging R&D session.

Microelectronic Packaging and Assembly for Large Sensor Area of X–ray and Pixel Detectors with Butted Modules and Sensor Die using Flip-Chip Bonding – Andreas Schneider - STFC

Andreas Schneider from the UKRI - Science and Technology Facilities Council provided an overview of a project which used an FR4 fanout interposer to enable 4-side tiling of a pixellated sensor module. He also presented a method to make a similar pixelated assembly on a flexible substrate, making use of a glass carrier to temporarily rigidise the substrate during assembly.

Laser Sintering of Silver Nanoparticle Paste Material for High Temperature Electronic Packaging – Guandong Liu – Heriot Watt University

Guangdong Liu from Herriot Watt University presented his work which makes use of laser sintered silver paste to mount components for extreme thermal environments (including SiC and GaN). He was able to show how this technique has delivered joints whose performance matches or exceeds those formed with conventional thermal sintering.

Monitoring degradation of a functioning embedded low pass filter as a function of simulated environmental exposure – Dan Flintoft - NPL

Finally, Dan Flintoff presented work which he has done towards his Engineering Doctorate. He has investigated functional degradation of RC filters embedded within a PCB, and was able to show how thermal cycling and elevated humidity have resulted in performance degradation as well as some outright failures. The session concluded with a variety of questions for each speaker.

Session 6 – The Future

Keynote Presentation: A Sustainable Future Requires Heterogeneous Integration - Francoise von Trapp – 3d InCites

Francoise gave an overview of the UN's 17 Sustainable Development Goals and how many of them relate directly to the semiconductor industry, and how customers, employees and investors now expect businesses to be working to reduce their Environment, Social and Governance issues. The talk moved to touch on how HI in particular can help to meet the energy-saving and data requirements of sustainable development, plus enabling technologies (EVs, autonomous transport, smart cities and smart healthcare) that contribute to meeting the UN over-arching goals. The UN goals also touch on reducing inequalities in society, and the semiconductor industry is waking up to the issues of gender and racial inequalities and how businesses can benefit from increasing the equity and inclusion for a more diverse workforce.

Equality, Diversity and Inclusivity: Haven't we done enough already, and why does this matter to the UK Microelectronics Industry - Anne Vanhoestenberghe - UCL

Anne approached the topic with a stronger focus on the UK supported by a selection of interesting research to show how many factors can influence the recruitment and retention of certain "under-represented" sections of society in the semiconductor industry - be that in terms of race, gender and/or disability. She concluded with some ideas that companies could consider to improve equality: Reverse mentoring (to promote mutual understanding), non-negotiable starting salaries and wage transparency, increased transparency about hiring decisions, and 360° appraisals.

Networking Session

Zoom Room 1 – Sustainability, Equality, Diversity and Inclusivity

The networking session was attended by a mixed audience, including the two speakers of the 6th session. The discussion included people sharing personal experiences and everyone discussing practical options to improve the diversity of our community. There was an agreement that although we face a chicken and egg problem (to encourage interest from more people from diverse backgrounds, we need more visibility of diversity within the community, and to achieve this, the recruitment pool needs to be more diverse), we

should not wait for the situation to improve organically. Equality of treatment and opportunities was seen as crucial, and still sadly lacking, with a recognition of the danger that minorities are sometimes seen as "having it easier (than dominant groups) because the PC brigade", which devaluates their achievements, and blatantly fails to recognise the ever present barriers to outsiders.

The discussions were very positive and constructive, there was a real desire from all in the room to drive change, which was really energising.

Zoom Room 2 - Packaging materials and processes

A total of 17 persons joined the networking group in zoom room 2. Good discussions were held covering:

a) Issues of using Au – Aluminium interconnections and "Purple Plague". A question raised during the event. Participants noted that this was a well known issue with wire bonding and such interconnections needed to be avoided.

b) Use of laser technologies in bonding, ablation, dicing and interconnections

c) Printed electronics and the development of suitable inks

d) Materials for Sintering Power electronic components

e) Recycling of materials, end of life aspects and design for reuse.

f) Production of Electric vehicles and manufacturing of Power modules

For further information on forthcoming events, please visit IMAPS-UK (www.imaps.org.uk)