

robustness and a lifetime about 2.3 higher for the ribbon bonding assembly. A higher contact surface, the low loop profile and stiffness for ribbons allow slowing down crack initiation and propagation between the Al bond and Al metallization on the top of the silicon die.

OE1_3 - Unusual defects, generated by wafer sawing: an update, including pick&place processing, *Peter Jacob¹ - ¹Empa Swiss Federal Laboratories for Materials Testing and Research*

Abstract: At ESREF 2008, the paper "Unusual defects, generated by wafer sawing: Diagnosis, mechanisms and how to distinguish from related failures" had won the Best Paper Award. In the meantime, new experiences were collected, related to new methods as laser stealth dicing and its specific ESD risks and additional failure mechanisms as backside damage, charging of foils and sawing residue damages. This paper explains in detail these failure sources, including detailed explanations on root causes and physical mechanisms as well as important hints for failure analysts how to distinguish related failure signatures from those, which look similar but are of other origin. As a real update to the paper of 2008, only really new failure mechanisms and new knowledge are published in this "updating" paper.

- **SESSION E1: Fatigue and modeling**

OE1_4 - Dynamical IMC-Growth Calculation, *Lutz Meinshausen¹, Kirsten Weide-Zaage² and Helene Fremont³ - ¹IMS University Hannover, ²RESRI Group IMS-AS Uni Hannover, ³IMS University Bordeaux*

Abstract: Material movement between solder joints and their contact pads leads to the formation of intermetallic compounds at the contact surfaces. Concentration gradients are responsible for this material movement. The intermetallic compound growth in 12x12mm Amkor® SAC305 ball grid array PoP packages including direct SAC-Cu contacts at their bottom bumps was investigated. Based on the resulting IMC thickness from measurements the average mass flux of Cu and Sn was calculated. Based on the determined activation energies (EA) and the diffusion constants (D0) from measurements the migration due to concentration gradients were determined by a routine for the dynamical calculation of IMC-growth migration effects. These calculations are validated by measurements

OE1_5 - Metal fatigue in copper pillar Flip Chip BGA: a refined acceleration model for the aluminium pad cracking failure mode, *Riccardo Enrico Vaion¹, Ruggero Alberti¹, Alberto Mervic¹ and Stefano Testa² - ¹STMicroelectronics, ²Stmicroelectronics*

Abstract: The increasing complexity of ASIC pushed the industry to innovative packaging solutions that are very challenging versus high automotive quality targets. This study is related to the characterization of an advanced Flip Chip BGA package with copper pillar interconnection and its reliability performance during temperature cycle stress test (aligned to AEC-Q100 Grade 1 perimeter [1]).

- **SESSION E1: Prototyping and analytic tools**

OE1_6 - Intrinsic Stress Analysis of Tungsten-Lined Open TSVs, *Lado Filipovic¹, Anderson Pires Singulani², Frederic Roger², Sara Carniello² and Siegfried Selberherr¹ - ¹Institute for Microelectronics, Technische Universität Wien, ²ams AG*

Abstract: The effects of silicon etching and subsequent metallization during the fabrication of tungsten-lined open TSVs is examined using a combination of measurements and simulations. The total stress through a deposited tungsten film is measured and finite element simulations are performed in order to separate the intrinsic and thermal stress components in the film. The data is then used to observe and model the stress through a TSV structure, which is etched using the DRIE process, resulting in scalloped inner sidewalls through the TSV opening. The scalloped structure is then compared to the ideal flat alternative with regard to the stress through the metal film and the TSV's electrical parameters, including resistance, capacitance, and inductance. It is found that the stress around the scallop varies significantly, but that the average stress through the tungsten in the flat TSV is not very different from the scalloped TSV. However, the resistance, capacitance, and inductance are found to increase in the presence of scallops.

OE1_7 - Virtual prototyping in a Design-for-Reliability approach, *Samed Barnat¹, Alexandrine Guédon-Gracia² and Helene Fremont² - ¹ISEFC, Université virtuelle de Tunis, Tunisie, ²IMS-Bordeaux*

Abstract: The main purpose of the paper is to present a methodological approach combining experiments and simulations for virtual prototyping in a Design-for-Reliability approach. Two examples illustrate the methodology and the importance of a wise choice of the adequate failure criterion for numerical modelling. In the first example, the stress induced in silicon is axial whereas it is radial in the second case. Strength data recorded from three-point-bend tests have been regarded in the first case, whereas in the second case, ball-on-ring test results have been considered.

- **POSTERS SESSION E1**

PE1_1 - Correlation between mechanical properties and microstructure of different aluminum wire qualities after ultrasonic bonding, *Marian Sebastian Broll¹, Ute Geissler¹, Jan Höfer², Stefan Schmitz², Olaf Wittler², Martin Schneider-Ramelow² and Klaus Dieter Lang¹ - ¹Technische Universität Berlin, ²Fraunhofer IZM*

Abstract: Three different heavy aluminum wire qualities were investigated regarding their microstructural evolution after ultrasonic bonding by electron backscatter diffraction and nanoindentation. The results complete the findings of our recent research regarding the effect of bonding mechanisms on the wire bond microstructure and its local mechanical properties. Local elastic-plastic material parameters of the bonded wires were approximated on the basis of the elastic anisotropy of crystals and a correlation between hardness and stress.

PE1_2 - Thermal cycle reliability of Cu nanoparticle joint, *Toshitaka Ishizaki¹, Masanori Usui¹ and Yasushi Yamada² - ¹Toyota Central R&D Labs., Inc., ²Daido University*

Abstract: Thermal cycle tests of -40/150 °C and -40/200 °C were carried out on joint samples by Cu nanoparticles and Sn-0.7 wt. %Cu solder. The sample joined by Cu nanoparticles at 300 °C was not damaged after -40/150 °C, but completely broken in the joint interface after -40/200 °C thermal cycle. The joint interface was strengthened as the joint temperature was increased to be 350 °C so that the Cu