Milli-seconds multi flip-chip bonding process via intense pulsed light irradiation for sustainability of semiconductor packaging manufacturing

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This presentation introduces a novel approach to achieving sustainability in semiconductor manufacturing through process innovation and design, with a focus on packaging technologies. In particular, it highlights a breakthrough in interconnection technology by replacing the conventional energy-intensive reflow soldering process with an ultra-fast, white-light solder bonding method [1]. The proposed white-light soldering process utilizes intense broadband light pulses lasting only tens of milliseconds to achieve solder joint formation. In this work, a numerical thermal transient simulation model was developed and validated by comparing with in situ monitoring results. The temperature profiles according to IPL parameters (pulse on-time, frequency, and pulse number) were investigated to effectively reduce bonding process time and maximum temperature of flip-chip bonding process.

The thickness of intermetallic compounds (IMC) was effectively reduced from 6 μm in the conventional reflow process to approximately 800 nm in the IPL flip-chip bonding process, as the process time was significantly shortened from 90 seconds to 56.4 milliseconds and the maximum temperature was lowered from 250 ℃ to 221.7 ℃. Die shear tests demonstrated that the IPL flip-chip bonding process improved die shear force by 30% compared to conventional reflow processes. This study demonstrates that the IPL flip-chip bonding process could produce 3D multi-chip packages with excellent mechanical reliability. Compared to conventional reflow soldering, this method offers approximately 40% reduction in energy consumption and significantly shortens the process time from several minutes to mere milliseconds.

This talk will explore how such innovative bonding design and process improvements contribute to sustainable semiconductor packaging and provide insights into the future of eco-efficient advanced packaging technologies.

References

1. Young-Min Ju, Seong-Ung Ryu, Jong-Whi Park, and Hak-Sung Kim, *Ultra milli-second flip-chip bonding process via intense pulsed light irradiation, in Press, Applied ACS Applied Materials & Interfaces, In Press* **(2025).**