Next-Generation Electrolytes for High-Precision Micro Bump Integration

Himendra Jha*, Jessica Stubbe, Christian Wendeln, Sandra Niemann, Ingomar Wolter, Recep Kocer

MKS Atotech Deutschland GmbH & Co. KG, Erasmusstrasse 20
10553 Berlin, Germany

The steady increase in interconnect density in advanced packaging continues to drive miniaturization of solder-based micro bump architectures. As pitch dimensions approach the lower limit of conventional three-layer pillar stacks, electrochemical deposition (ECD) processes must operate within increasingly narrow process windows. Reduced feature sizes intensify mass transport limitations, height variation sensitivity, and metallurgical interactions within confined volumes.

At these scales, uniformity is no longer solely a matter of wafer-level control but becomes a geometry-dependent challenge within complex hybrid bump layouts. Variations in pillar diameter, pitch, and local pattern density demand electrolyte systems capable of delivering geometry-independent deposition behavior while maintaining strict coplanarity and controlled vertical dimensions. Simultaneously, shrinking solder volumes amplify the impact of intermetallic compound formation and impurity-driven failure mechanisms, directly linking deposit chemistry to long-term reliability. As a result, electrolyte formulation evolves from a productivity parameter toward a central reliability driver in advanced packaging integration.

This work discusses the fundamental electrochemical and metallurgical constraints emerging in miniaturized micro bump technologies and outlines how tailored electrolyte design enables stable, high-uniformity deposition and controlled interfacial reactions within the solder-based regime. The results emphasize that further scaling of micro bump interconnects will depend not only on hardware innovation, but critically on chemistry-driven process optimization.

* *corresponding author e-mail:* himendra.jha@mksinst.com