3D X-Ray Analysis for Advanced Package Failures

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Historically, semiconductor packages were often viewed as nothing more than a cost-adder, required to protect the die while adding little to no benefit to device performance. While silicon technology scaled aggressively downwards in dimensions for many years, packaging technology by comparison scaled modestly. With the slowing of Moore's Law, growth in heterogeneous integration and the requirements for high performance computing are driving rapid package changes, making the package an integral component of overall system performance with new material and design requirements. Even as package interconnect and other structures shrink at faster than historical rates, package sizes are expanding in XY area simultaneously with increasing complexity from 3D stacking of package on package, die on die, and die on interposers.

 A key to rapidly increase the yield and reliability of these advanced packages is the ability to analyze defects and understand failures. Non-destructive imaging methods that can reveal information about interior defects, such as 2D X-ray and acoustic microscopy, are one of the first steps in a failure analysis (FA) workflow after a failure is confirmed. As package dimensions shrink, and the number of layers in the package increases, these methods become less effective. This is driving the high-resolution 3D imaging method of X-ray microscopy (XRM) into the standard FA workflow as a core technique. Unlike traditional methods of microCT and X-ray laminography, XRM is proving highly effective for non-destructively localizing and imaging defects at high resolution even within large intact packages. XRM can image bumps and through-silicon vias (TSV) at different locations on 300mm wafers without significant loss of resolution. With its capability for high-resolution, non-destructive imaging of a wide range of samples sizes, XRM is an effective and versatile instrument aiding package development, process quality inspection, and failure analysis of advanced packages.