Characterization and Failure Analysis of 3D Integrated Systems using a novel plasma-FIB system

Laurens Kwakman[1], German Franz[1], Armin Klumpp[2] and Peter Ramm[2]

(1) FEI Electron Optics, Achtseweg Noord 5, 5700 KA Eindhoven, the Netherlands
(2) Fraunhofer EMFT, Hansastrasse 27d, 80686 Munich, Germany

ABSTRACT

Today 3D integration based on TSV's is a well accepted approach to further improve Integrated Circuits in terms of miniaturization, performance, power consumption and heterogeneous integration [1]. However, 3D integration comes with the introduction of many new processes and materials that may affect behavior and reliability of the overall system [2]. Therefore, there is a strong demand for physical characterization and failure analysis and more explicitly, also for tools and techniques that allow for easy chip access, navigation to the site of interest and that can provide physical information at the nm scale within a field of view of up to 100 x 100 μm^2.

In the framework of the European project JEMSIP-3D, a novel plasma-FIB (Focused Ion Beam) platform has been developed and evaluated by the project partners. This new platform has been characterized in terms of mill rates, resolution and ion assisted CVD kinetics and effective methods have been developed to suppress the curtaining that may appear on X-sections due to variations in material milling rates. The plasma-FIB platform has also been used to analyze failures of 3D integrated systems caused by TSV formation and the permanent bonding process. Figure 1 shows the application of the novel FIB analysis technique on a 3-layer stacked device with cross-sections of the areas of interest (IMC bond, TSV). Compared to classical FIB systems, the new equipment allows removing material significantly faster while maintaining good resolution at low beam currents, important for the subsequent analysis. The characteristics and merits of the novel plasma FIB platform and the resulting failure analysis will be discussed in detail.

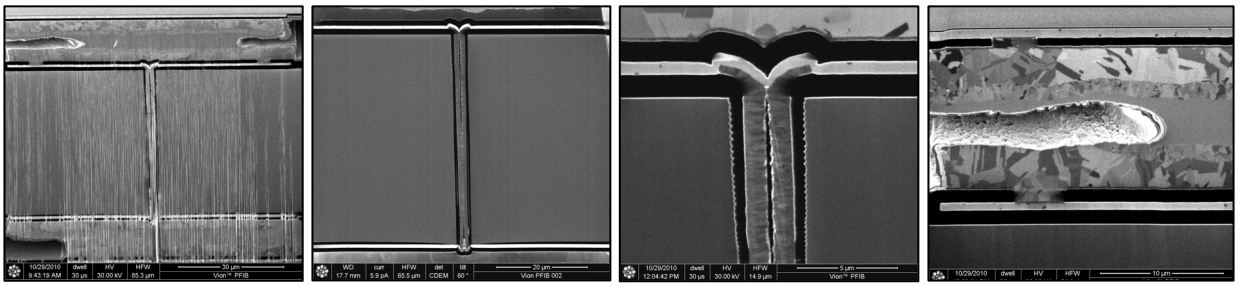

FIGURE 1. Plasma-FIB based analysis of the 3 level stacked device. Left to right: "curtaining", clean section, ICV, IMC bond.

REFERENCES:

[1] Semiconductor Industry Association, "The International Technology Roadmap for Semiconductors", 2009 edition.
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