Investigation of isolation liner and Cu diffusion barrier by (PE)ALD, (PE)CVD and FAST for TSV application.

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As one of the key enabler of more than Moore law, Through Silicon Via (TSV) has been widely studied but not largely adopted by advanced packaging industry. The main factor which was limiting its adoption is the higher overall integration cost when compared to standard packaging solution. New schemes have emerged to tackle this cost issue, like Fan-Out wafer level package, but they rise new problematic and will face the same scaling/price trend for next generations while solutions can already be easily implemented for TSV.

At the present time, TSV key films, i.e. isolation, barrier and Cu seed layer, are depending on (PE)CVD and PVD deposition systems in high volume manufacturing. However, these deposition methods are not able to answer actual TSV challenge: thick and conformal layers. On the other hand, the ideal solution for conformal layers is the (PE)ALD technique, but its low deposition rate makes it incompatible with the thickness required in the TSV integration. Thus, a new technique at the crossroads of (PE)CVD and (PE)ALD, the Fast Atomic Sequential Technique (FAST®) was developed. This paper will present a comparison of these three different deposition methods to address the challenges of TSV.

Process development, based on standard chemistries such as TEOS for SiO_2 deposition and TDEAT for TiN deposition, was done to obtain processes optimised to TSVs requirements. As shown figure 1, comparison of the deposition rate, conformality, minimum deposition temperature and resistivity (for TiN) or breakdown voltage (for SiO_2) were done for the three deposition techniques of ALD, CVD and FAST.

The comparison will be supported by an investigation of the influence of deposition parameters such as pressure, flow ratios or plasma parameters, for ALD, CVD and FAST. Extensive data on vias with aspect ratios going from 4:1 (aspect ratio currently used in mass production) and up to 20:1 (aspect ratio forecasted for future integration) will open a discussion on the best techniques for each requirements and on the compromises required for successful integration in TSVs.

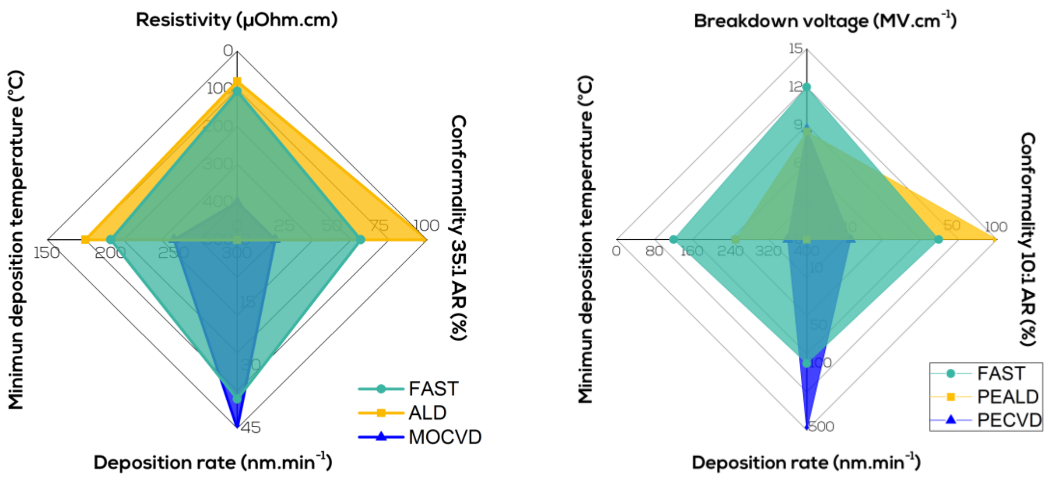

Figure 1: Main characteristics of ALD, CVD and FAST techniques for TiN (left) and SiO_2 (right) deposition.