APPLICATIONS OF X-RAY REFLECTIVITY TO DEVELOP AND MONITOR
FEOL AND BEOL PROCESSES FOR SUB-65NM TECHNOLOGY NODES

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As individual devices of Integrated Circuits (i.e. transistors) are to continue shrinking and delivering better performance, while containing power consumption, the development of Front End Of the Line (FEOL) and Back End Of the Line (BEOL) processes for sub-65nm technology nodes requires accurate in-line characterization to control the thickness and the physical properties of extremely thin layers.

X-Ray reflectivity (XRR), which is a rapid and nondestructive metrology technique, has moved from offline physical characterization laboratories to semiconductors manufacturing lines. This paper aims at reviewing applications of XRR for the monitoring and development of advanced BEOL and FEOL processes.

XRR is a valuable technique for FEOL process control. It helps to explore and identify high-k gate dielectrics and metal gate electrodes that enable the fabrication of optimized gate stack. XRR characterization of Hf-based high-k materials, as well as W-based metal gate will be assessed for different deposition techniques. Moreover, XRR is an attractive alternative to spectroscopic ellipsometry to determine the thickness and the physical properties of starting materials that either improve heat dissipation properties or improve mobility in transistor channels: silicon-on-insulator with insulator being a material of higher thermal conductivity than SiO2 or strained silicon, respectively.

XRR also helps for BEOL process control, either alone, to monitor the thickness and density of very thin barrier layers and the density of porous low-k layers, or coupled with X-Ray fluorescence to monitor the thickness of self-aligned thin barrier layers.