

## Characterization of Nano-laminate Structures using Grazing Incidence XRD

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ZrO<sub>2</sub>-Al<sub>2</sub>O<sub>3</sub> laminate layers deposited using atomic layer chemical vapor deposition (ALCVD) have been studied with a high temperature grazing incidence X-ray diffraction spectrometer (GIXRD). The work is based on a principle similar to X-ray reflectivity. In the diffraction spectra of the laminate samples, a sharp, intense peak due to the constructive interference of the X-ray beams reflected by the interfaces between neighboring lamina has been observed. From the position of the peak, the spacing of the nearest correlative interfaces, or the thickness of a double-lamina, can be determined. From the intensity and the width of the peak, information on the thickness uniformity, the repeatability of the lamina thickness and the sharpness of the interfaces can be evaluated.

By studying the difference in structure among the layers deposited using different recipe, the ALCVD deposition rate of Al<sub>2</sub>O<sub>3</sub> on ZrO<sub>2</sub> and that of ZrO<sub>2</sub> on Al<sub>2</sub>O<sub>3</sub> have been obtained. By observation of the in-situ peak shift during the high-temperature measurement, the volume change (expansion or shrinkage) of the lamina has been studied as a function of temperature. The miscibility of ZrO<sub>2</sub> and Al<sub>2</sub>O<sub>3</sub> has been also studied through the intensity decrease of the peak during the measurement.