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Design and Building of a Multiple Internal Reflection FT-IR Spectrometer

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In view of the film uniformity, thickness controllability, and low thermal budget, etc., the application of self-limiting atomic layer deposition (ALD) is accelerating with apparently significant benefits in the fabrication of semiconductor devices. Understanding of the chemical reactions at surfaces and interfaces in ALD processes is important because of the negligible effects of surface and interface regions in the applications of nm-scale thin films. To investigate the surface and interfacial reactions in an ALD process, a variety of techniques such as FT-IR spectroscopy, mass spectroscopy, and X-ray photoelectron spectroscopy (XPS) have been applied. Among these techniques, the multiple internal reflection (MIR) infrared spectrometry is the most powerful tool to obtain information about the reaction mechanisms and the chemical states of the interfacial layers between the substrates and the films. Therefore, we have designed and built an MIR FT-IR instrument coupled with single reflection capability, and tested it for an ALD reaction. In this study, we present the systematic scheme of *in-situ* MIR and single reflection instrumentation. In addition, the initial ALD mechanism of the growth of Al_2O_3 thin films on the Si(001) surface is revealed by this technique with dimethylaluminum isopropoxide [$(CH_3)_2AlOCH(CH_3)_2$] and water as the respective sources for aluminum and oxygen.