UHV FT-IR Spectroscopy for Atomic Layer Deposition: An Instrumental Contribution

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Abstract: In atomic layer deposition (ALD) studies, there is a growing demand to adapt a large measurement cell, an ultra-high vacuum (UHV) chamber or particularly an ALD preparation chamber to FT-IR spectrometer optics. The combination of the FT-IR technique and an external preparation chamber enables in-situ monitoring of ALD processing from fundamentals to applications. Bruker provides multiple innovative adaptation solutions of customized chambers to FT-IR spectrometers.

Keywords: IR spectroscopy, ALD, IRRAS, transmission, vacuum, combined technique

Infrared spectroscopy as a very informative and non-destructive analysis method has become indispensable in most research fields. Bruker's research FT-IR spectrometers are well known for their high flexibility and usability especially in connection with external customized sample chambers [1]. The research spectrometer series with complete vacuum optics layout are especially suited for the external adaption of UHV (ultra-high vacuum) chambers.

The fundamental advantage of using FT-IR spectroscopy in vacuum is to avoid the adsorption of atmospheric moisture and other gas species. Vacuum spectrometers provide a better stability and reproducibility in comparison to the dry air/nitrogen purged spectrometers. Furthermore, the adaption of vacuum chambers with vacuum spectrometers is technically more efficient and reliable. Bruker has successfully installed the adaption for different UHV systems provided by several suppliers [2-4].

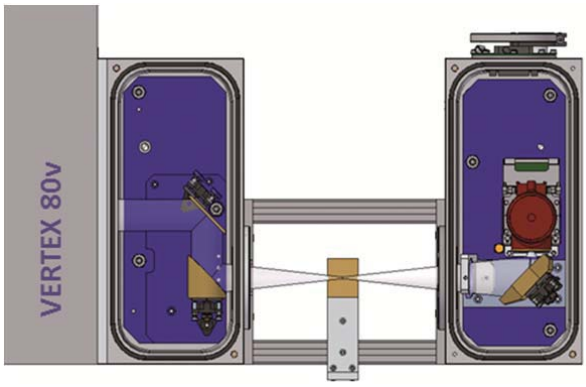

Fig. 1. The external UHV adaptation- and detector chamber is shown in the typically supplied configuration in order to allow performance test prior to the customer supplied UHV chamber being adapted [1].

A standard configuration is shown in figure 1 without a UHV system. An adaption chamber is attached to the spectrometer and contains a kinematic base plate with transfer optics. The other free-standing detector chamber includes additional transfer optics and a detector mount. Both chambers are prepared for a vacuum tight adaption to a UHV system. In this case the UHV system will be located between the adaption chamber and the detector chamber. This configuration provides maximum versatility and plenty of space for large UHV chambers or research done with other combined UHV analysis techniques. Both transmittance and reflection (IRRAS) configurations are available.

Another possibility to combine FT-IR spectroscopy to an existing UHV system is to adapt the UHV chamber in the modified sample compartment of a VERTEX 80v vacuum spectrometer. Two spectrometer internal motorized off-axis parabolic mirrors can be driven in two positions respectively for transmission and reflection measurements at grazing incidence [5-6].

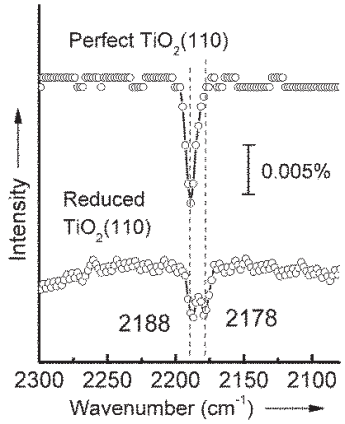

Fig. 2. IRRAS data for CO adsorbed on perfect and reduced r-TiO_2 single-crystal surface at 110 K [7].