

## Analysis of multi-layer thin film materials using benchtop XRD and XRF systems

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In industrial as well as research laboratories, the demand for the analysis of thin films and coatings has been growing, thanks to the development of a large variety of applied materials. Such materials are for example used in photovoltaic collectors for green energy harvesting, vice versa as materials for generating light in LEDs and Lasers or as materials for sophisticated optical applications.

X-ray diffraction (XRD) is one of the commonly used analysis techniques to characterize the crystallographic structure of thin films and coatings. Determining the thickness of layers can be challenging but is important to control the properties of the materials. Both, X-ray reflectometry (XRR) and X-ray fluorescence spectroscopy (XRF) allow determining the thickness of layers even in multi-stack systems. The applicability of both methods depends on the composition and nature of the sample. On the other hand, controlling the crystallographic nature of the deposited material is crucial because physical properties like electric conductivity or transparency depend on it.

Recently a less hazardous alternatives for CdS which is used as a buffer material in CIGS (Copper Indium Gallium Selenide) solar cells was investigated.<sup>[1]</sup> Such solar cells are advantages compared to more common bulk solar cells because of the reduced requirement of resources. Additionally, the interest in thin film battery materials is showing an increase because it enables unique battery solution e.g. batteries directly on chips or flexible batteries. More commonly optical coatings are used in smart phone camera lenses and even as optics for X-ray analytical instrumentation.

Technological advancement allows for miniaturization and therefore leads to more capable benchtop solutions. The Thermo Scientific™ ARL™ EQUINOX benchtop powder diffractometers and the ARL™ Quant'X benchtop energy dispersive X-ray fluorescence spectrometer (EDXRF) are both designed to conveniently carry out measurements on thin film samples of various types

[1] N. Winkler, R. A. Wibowo, W. Kautek, T. Dimopoulos, *J. Mater. Chem. C*, **2019**, 7, 3889.

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