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## Nanometer and sub-nanometer layer reference samples for X-ray fluorescence - New results and applications

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Non-destructive X-ray spectrometry methods such as XRF, TXRF as well as GIXRF/GEXRF allow determining the elemental composition of unknown bulk and layered samples. However, in most cases well-defined standard or reference samples are required if quantitative information about layer thickness (nm) or mass deposition ( $\text{ng}/\text{mm}^2$ ) shall be deduced from the fluorescence radiation (cps). Internal or external standards such as dried or  $\mu\text{L}/\text{nL}$ -droplets may be used for this quantification but problems can occur in sample preparation, measurement and evaluation. XRF signals from the sample carrier may further increase the signal background and decrease sensitivity especially for low concentrations.

Ultrathin silicon nitride membranes have been used as low-background reference sample substrates for several years. Further, dedicated physical vapor deposition (PVD) methods are applied to provide laterally extremely homogeneous layered multi-element reference samples of well-defined mass deposition in the range of few nm and even much below the mass deposition of an atomic monolayer.

As fabrication and characterization becomes cost-efficient for larger production batches, market research and evaluation of demand in research and industry is essential. New reference systems are suggested, focusing on transition metals of period 4 (3 to 8 keV) or period 5 and 6 (8 to 21 keV), plus multi-element sub-monolayers in the pm range.

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