

TRACE ELEMENT DETECTION USING MONOCHROMATIC WAVELENGTH DISPERSIVE X-RAY FLUORESCENCE

George J. Havrilla, Michael Collins, Velma Montoya, Zewu Chen, Fuzhong Wei

Los Alamos National Laboratory and X-ray Optical Systems

A prototype XRF instrument with nominal sub-ppm sensitivity has been developed for trace elemental analyses. The prototype instrument is based on using doubly curved crystals (DCCs) as X-ray optical elements to provide unique capabilities in a bench top instrument. The technology is defined as monochromatic wavelength dispersive X-ray fluorescence (MWDXRF). The technique uses a DCC on the X-ray source to convert the Bremsstrahlung output of an X-ray tube to a monochromatic output for excitation. In this instance, the RhKa line at 20.214 keV is produced to excite the sample. The X-ray emission from the sample is collected by a second DCC optic in front of the detector. The specific element line must be specified for the collection DCC. The collection DCC offers a sensitive and selective collection of the analyte signal and directs it to the detector. In this prototype, uranium and yttrium have been selected as analytes, using the ULa line at 13.613 keV and YKa line at 14.597 keV. The MWDXRF arrangement offers significant improvements in sensitivity and selectivity not typically found in conventional XRF instruments. This is due to the monochromatic excitation as well as signal collection. The collection optic transmits the analyte x-rays to a silicon drift detector. The x-ray source, sample, collection optic and detector are all mounted on motion controlled stages for the critical alignment of these components. Only the analyte X-rays emitted by the sample reach the detector. The prototype instrument performance will be demonstrated for sensitivity and selectivity of uranium, thorium and yttrium detection, which are expected to be at the sub-ppm level. The MWDXRF selectivity will be demonstrated by analyzing these elements in the presence of both high concentration salt matrices and high concentrations of nearby high Z elements.