

The New X-ray Induced Electron Emission Spectrometer

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The new spectrometer for X-ray Induced Electron Emission Spectroscopy (XIEES) has been recently developed in KRISS in collaboration with PTI (Russia). The spectrometer allows to perform research using the XAFS, SXAFS, XANES techniques (D.C.Koningsberger and R.Prins, 1988) as well as the number of techniques from XIEES field (L.A.Bakaleinikov et al, 1992). The experiments may be carried out with registration of transmitted through the sample x-rays (to investigate bulk samples) or/and total electron yield (TEY) from the sample surface that gives the high (down to several atomic mono-layers in soft x-ray region) near surface sensitivity. The combination of these methods together give the possibility to obtain a quantitative information on elemental composition, chemical state, atomic structure for powder samples and solids, including non-crystalline materials (the long range order is not required).

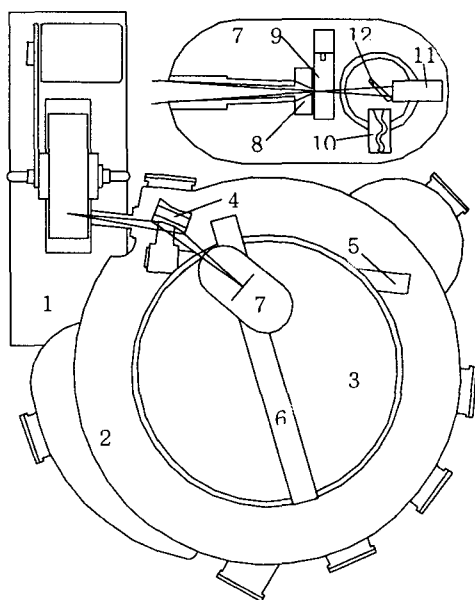


Fig.1. Optical design of spectrometer
1- x-ray generator; 2- vacuum chamber; 3- optical table; 4- monochromator; 5- monochromator rail; 6- sample goniometer rail; 7- sample goniometer; 8- exit slit; 9- first proportional counter; 10- channeltron; 11- second proportional counter; 12- sample holder.

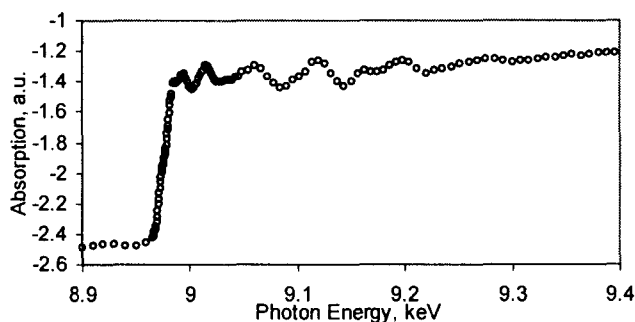


Fig.2. K-edge XAFS spectrum of Cu

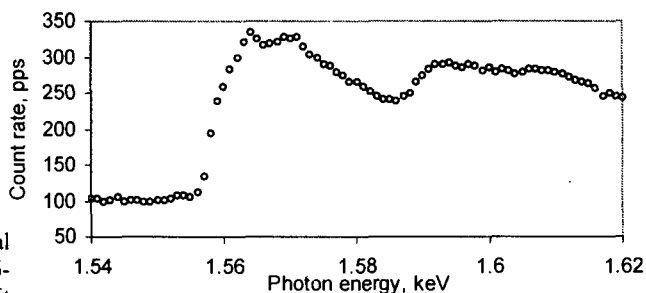


Fig.3. K-edge XAFS spectrum of Al foil

The optical design of spectrometer is made according to Johannesson true focusing schematics and presented on the Fig.1. Five stepping motors are used to maintain the focusing condition during the photon energy scan (crystal angle, crystal position along rail, sample goniometer rail angle, sample goniometer position along rail and sample goniometer angle relatively of rail). All movements can be done independently and simultaneously that speeds up the setting of photon energy and allows the using of crystals with different Rowland radii. At present six curved crystals with different d-values and one flat synthetic multilayer are installed on revolver-type monochromator. This arrangement allows the wide range of x-rays from 100 eV up to 25 keV to be obtained. Another 4 stepping motors set exit slit width, sample angle, channeltron position and x-ray detector position. The differential pumping allows to unite vacuum chambers of spectrometer and x-ray generator avoiding the absorption of soft x-rays on Be foil of a window and in atmosphere. Another feature of vacuum system is separation of walls of vacuum chamber (which are deformed by the atmospheric pressure) from optical elements of spectrometer. This warrants that the optical elements are precisely positioned. The detecting system of the spectrometer consists of two proportional counters, one scintillating detector and one channeltron detector. First proportional counter can be used as I_0 -detector in transmission mode or by measuring the fluorescence from exit slit edge. The last installation can be used to measure the reference data (that is necessary in XANES measurements), in this case the reference sample is installed on slit knife edge. The second proportional counter measures the intensity of x-rays transmitted through the sample. The scintillating detector is used in the same way but on the air for the hard x-rays and for alignment purposes. Total electron yield from the sample is measured by channeltron. The spectrometer is fully controlled by special software that gives the high flexibility and reliability in carrying out of the experiments. Fig.2 and fig.3 present the typical XAFS spectra measured with spectrometer.

References

1. L.A.Bakaleinikov et al, *Advances in X-Ray Analysis*, 1992, Vol.35, pp.1243-1246.
2. *X-Ray Absorption, Principles, Applications, Techniques of EXAFS, SEXAFS and XANES*, edited by D.C.Koningsberger and R.Prins, John Wiley & Sons, 1988.