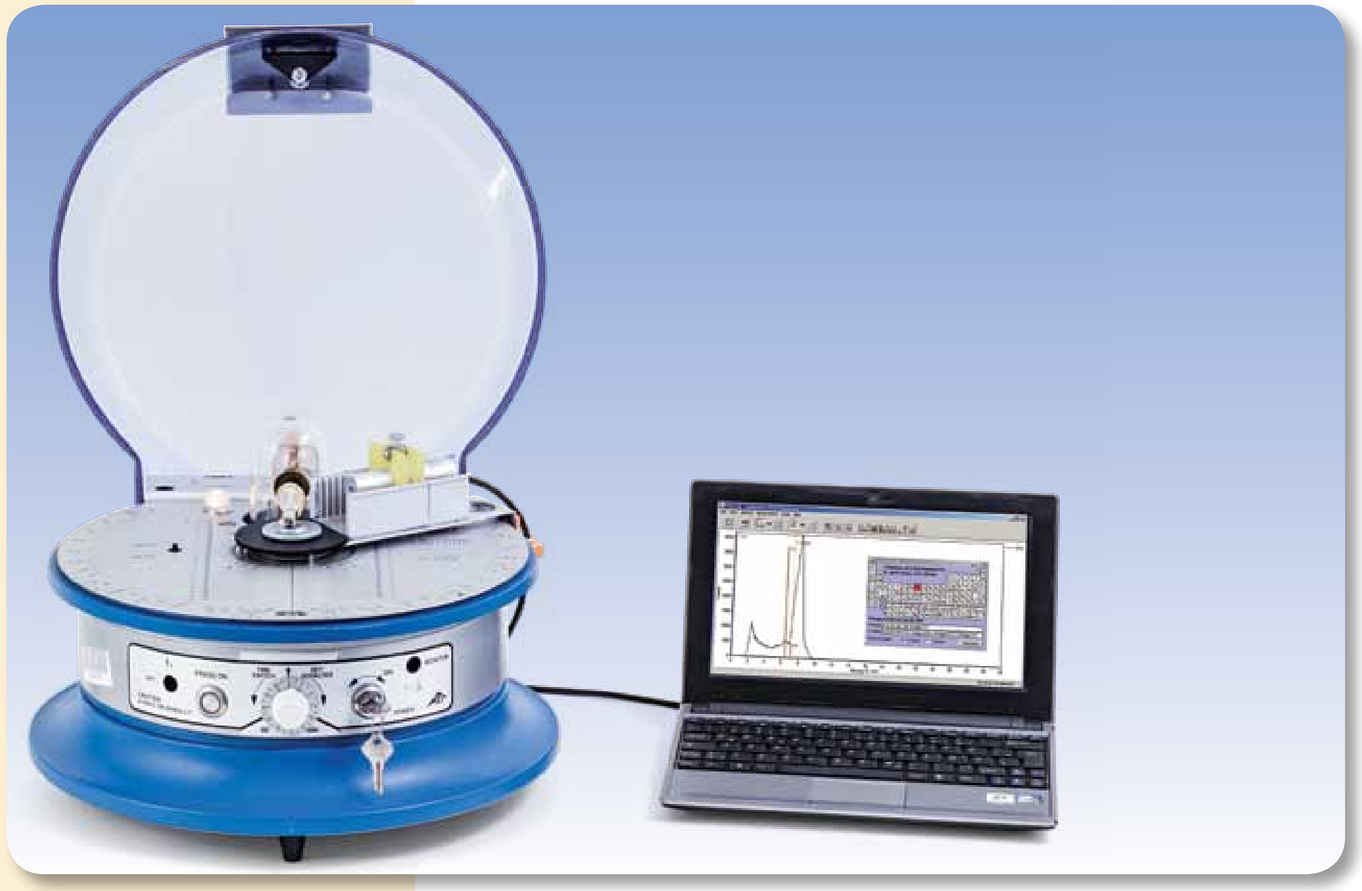
X-RAY FLUORESCENCE



EXPERIMENT PROCEDURE

- Record X-ray fluorescence spectra for various material samples.
- Identify the chemical components on the basis of characteristic X-ray lines.

OBJECTIVE

Non-destructive analysis of chemical composition

SUMMARY

Chemical elements can be uniquely identified on the basis of their characteristic X-ray radiation. This is because the energy of that radiation is dependent on the atomic number of the element. X-ray fluorescence analysis involves exciting this characteristic X-ray radiation by bombarding the material to be investigated with highly energetic X-ray quanta. This experiment analyses the chemical composition of multiple material samples. Comparisons are made between wrought iron and stainless steel, copper, brass and bronze, as well as a variety of coins.

REQUIRED APPARATUS

Quantity	Description	Number
1	X-Ray Apparatus (230 V, 50/60 Hz)	1000657 or
	X-Ray Apparatus (115 V, 50/60 Hz)	1000660
1	Basic Set Bragg	1008508
1	X-Ray Energy Detector	1008629
1	Set of Fluorescence Samples	1012868
Additionally recommended:		
	Coins	

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UE7020100

BASIC PRINCIPLES

Chemical elements can be uniquely identified on the basis of their characteristic X-ray radiation. This is because the energy of that radiation is dependent on the atomic number of the element. This means that the chemical composition of a material can be determined by measuring the characteristic X-ray radiation. Chemical bonds between the elements are not relevant to this since they do not involve the inner shells of atoms where X-ray transitions occur.

X-ray fluorescence analysis involves exciting this characteristic X-ray radiation by bombarding the material to be investigated with highly energetic X-ray quanta. The excitation energy needs to be higher than the characteristic radiation to be expected, meaning that it may not be possible to excite high-order transitions in the K series of elements. The analysis therefore needs to concentrate on transitions in the L series, see Fig. 1.

An X-ray energy detector is provided for this experiment in order to record the energy spectra. The incident X-ray radiation causes interactions between electron/hole pairs in the atoms of crystals forming a silicon PIN photodiode. The overall charge associated with these is proportional to the X-ray energy. The charge is converted into a voltage pulse proportional to the X-ray energy which can then be transmitted to a computer as a digital value. Evaluation software is used to plot the distribution of pulses of specific amplitude. When the energy is calibrated, this distribution is equivalent to the energy spectrum we are seeking.

This experiment uses an X-ray tube with a copper anode as its source of radiation. The chemical composition of multiple material samples are analysed and comparisons made between wrought iron and stainless steel, copper, brass and bronze, as well as a variety of coins.

EVALUATION

The evaluation software allows the measured energy levels to be compared with values quoted in literature for the characteristic radiation wavelengths of the materials in question.

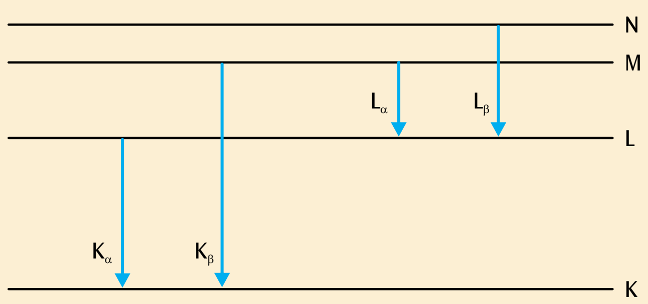

Fig. 1: Simplified energy band diagram for an atom with characteristic X-ray lines.

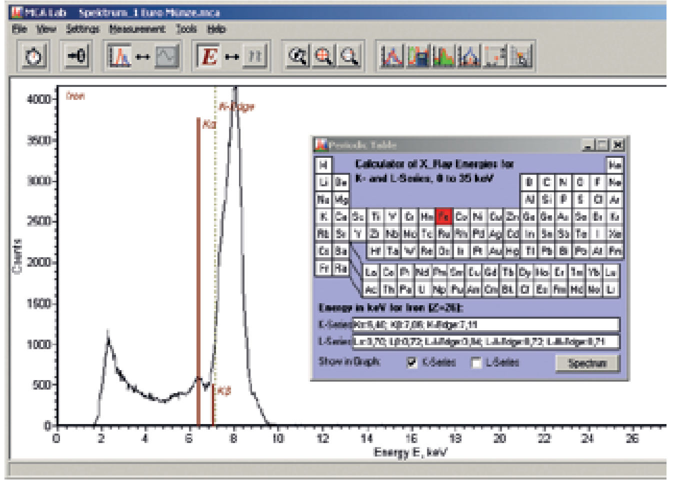

Fig. 2: X-ray fluorescence spectrum for a one euro coin

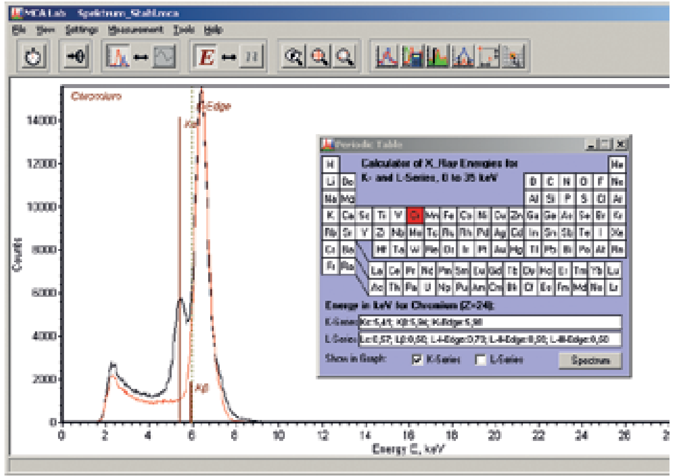

Fig. 3: X-ray fluorescence spectra for wrought iron (red) and stainless steel (black).