

ROENTGEN - FLUORESCENT ANALYSIS (RFA)

? What's an RFA?

Roentgen - fluorescent analysis (below just RFA) is a method, which is used for chemical determination of the object that is examined (or even for an assignation of its age). It is ranked among the most widespread methods, which are making use of an ionizing radiation.

It is a method, which is non - destructive. It means that RFA don't harm or anyhow affect the estate of the object, in which it was before the examination. That is a big advantage in studying historic relics, examining the archeological findings and works of art. Mainly, this method is used by archeologists and restorers. The KDAIZ (The department of dosimetry and application of ionizing radiation) keeps in close touch with them.

? More detailed

We can divide the RFA in two operations that have to be done, before we reach the results of measuring. First, we have to measure out data via the roentgen-fluorescent analyzer. Then we have to analyze the results via the computer software. Of course, it is possible to do both operations independently from each other, which is often good to do to spare the time.

This method is based on excitation of a specific radiation (by suitable primary radiation) and detection of a specific X-ray radiation, which engender with an emission of electron (from some energetic level in atom). This space will be filled with an electron from some different energetic level, whereas this difference of energies will be de-excited as a photon of a specific radiation, or it will be handed over different electron. This radiation is detected and the gained informations are analyzed.



A measured banknote from the Czech National Bank

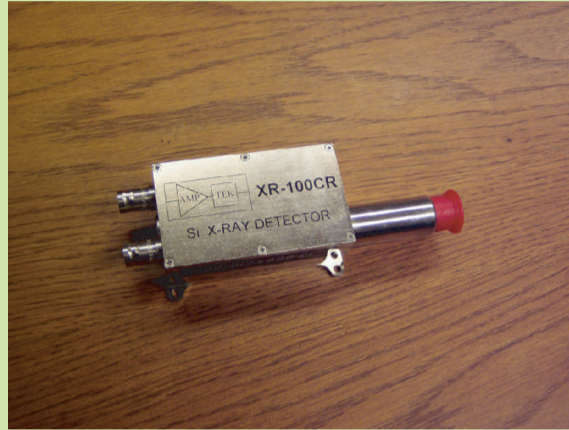
The origin of primary radiation



A measured artefact, an angel from some Moravian church, we were investigating what material it was made from

The examined assay

The silicon detector



The detector



The Upshot - Plotting

The plotting of measuring is the last step to finish. There are some computer programs, which can analyze data from the detector and do a graph from them. X-axis determines the energy. The size of energy is specific for every energetic level in the electron shell to every element of the periodic chart of elements. More right are the elements with bigger "proton number" or more energetic levels of one element. Most frequently represented energetic levels are $K\alpha$ and $K\beta$. $K\alpha$ is mostly on the surface or not so deep, as $K\beta$. $K\alpha$ has smaller energy than $K\beta$. So it's more left on the X-axis. On the Y-axis is displayed frequency of captured particles for every value of X-axis.

We can analyze the result with the aid of tables, in which are to all elements specified energies for individual energetic levels of electrons. So, we'll look what energy has the examined spur on the graph (peak). And accordingly we can establish what that element is. We can work like this, when we want know just for guidance, what elements contains the assay under examination. If we want e.g. reckon percentage scheduentation of one element in assay, then we have to reckon what amount of that element is in there. This information is determined by the area of the peak of given element. If we have two of them ($K\alpha$ and $K\beta$), then we count up both two. We got some number. We can express it by percent like: (area of the peaks of an element X) / (area of all the peaks of measured spectra). For reckoning of the areas of peaks is using the computer software AXIL. It's very easy to operate. It can reckon areas of single peaks, depending up the background. (Background is the unnoticed part of spectra, with resembling frequency in most of points of the X-axis). AXIL will show us, what elements are in the spectra. It's a big help to this method.

Through the use of RFA we can also find depth layering of single elements in examined object. We reckon ratio $K\alpha/K\beta$. More at the surface are the elements with bigger ratio. Deeper are the ones with smaller ratio.

At measuring pictures or handwritings is possible to use the table that was made at KDAIZ. According to the results we measure out, we can find there the color of this object. Every color has a period of time written there, when it was most often used and when it was developed. It's possible to tell approximate age of the object.

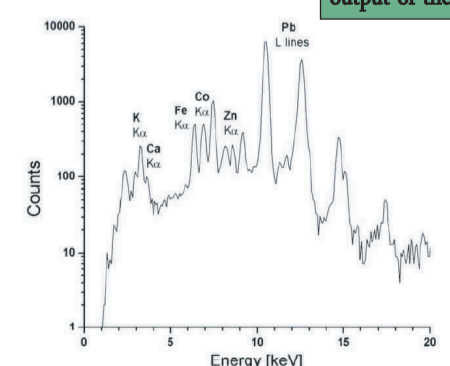
? The Apparatus

Roentgen - fluorescent analyzers are either transferable or bigger sized. The smaller ones are convenient because of the fact that they can be moved all over the Czech Republic (where the measuring is mostly placed) to follow the examined object. Though, the disadvantage is, that ionizing radiation is much more intense (and more dangerous), to increase the speed of measuring data from the assay. The bigger ones have the advantage of shielding, so there is no fear of irradiation.

Unfortunately, this is at the expense of time. Data from the assay are obtaining more slowly and it is necessary to measure several tens of minutes for having accurate results. (Actually, the phrase of "fear of irradiation" is maybe too overstated!! Ionizing radiation is in both cases very forceless. And the possibility of irradiation by measurable assessment of radiation only by manipulating with the apparatus is low.) The first important part of it is the origin of primary radiation (which, as it was mentioned, will add energy to some electron, which then emits). We were using a molybdenous X-ray tube, because of a well-looking resultant spectrum. It's possible to set up the tension on the X-ray tube, and also the mains of el. current to the X-ray tube. There is also a water or air cooling by the apparatus because of hot weather in summer or when the measuring is long. Next, we have here the silicon detector of the X-ray radiation. It's capturing the specific radiation that ensued, when the electron in the assay emitted. Informations from the detector are sent to computer, where they are analyzed.

We know that the angle of incidence equals to the angel of reflection. So if we want to capture utmost specific radiation on the detector, our requirement is to have the smoothest surface possible, in order to not reflect the radiation all ways.

All apparatus is shielded by glass coat, thick a few centimeters, so the safety at measuring is ensured.



A graph, that a computer software painted, like an output of the measuring.