

FULLY NON-DESTRUCTIVE ELEMENTAL ANALYSES OF COPPER-ALLOY ARTEFACTS WITH NEUTRON RESONANCE CAPTURE BETWEEN 1eV AND 10 keV

H. Postma¹, M. Blaauw¹ and F. Corvi²

¹ IRI, University of Technology Delft, Mekelweg 15, 2629 JB Delft, the Netherlands

² IRMM, Retieseweg, Geel B-2440, Belgium

Neutron capture resonance analysis (NRCA) using a pulsed neutron beam and the time-of-flight (ToF) technique is a new method to determine the elemental compositions of artifacts. Neutron capture by an object can be observed by detecting the prompt capture gamma-radiation. Energies of resonance peaks in the ToF spectrum are the "fingerprints" for elements. Since it is not necessary to determine the energy of the gamma-rays with any precision it is possible to use a detector system with high detection efficiency.

It is not necessary to take parts from an object for the analysis, or to clean the surface or to do other things which might damage the object. Therefore NRCA is especially of interest for studying fragile, small or valuable objects from which one does not want to, or cannot take samples, or for which cleaning of even a small part of a surface is not desirable. Knowledge of the elemental composition of artifacts might be useful for archeological or historical studies or to check the authenticity of an artifact.

Recent experiments at the GELINA facility in Geel (Be) show that indeed NRCA is a useful way to recognize elements on the basis of the energies of resonance in the ToF spectrum. We applied NRCA to several copper-alloy artifacts. In the studied objects very little activity was induced, which also disappeared quickly.

Thus resonance energies allow to recognize elements of an object. In addition a quantitative analysis is possible on the basis of resonance areas. In the case of our artefacts the amounts of several elements (notably Sn, As, Zn, Fe, Sb, Ag, Au) were determined as ratios to copper. For strong resonance it is necessary to take self-shielding into account. The effect of self-shielding made it possible to determine the absolute amount of copper by comparing the areas of a weak and a strong copper resonance, and thus also absolute amounts of the other components could be determined.

The method of NRCA will be discussed in relation to the experiments carried out in Geel with a number of copper-alloy based artefacts from different cultures (a.o. Celtic, Persian, African). The results of a selected number of studied cases will be briefly discussed within their archaeological or historical context.