ENHANCING NAA RESULTS BY USING ROBUST STATISTICS

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ABSTRACT

Neutron Activation Analysis (NAA) is an analytical technique where an unknown sample is submitted to a neutron flux in a nuclear reactor, and its elemental composition is calculated by measuring the induced activity produced. By using the relative NAA method, one or more well-characterized samples (usually certified reference materials - CRMs) are irradiated together with the unknown ones, and the concentration of each element is then calculated by comparing the areas of the gamma ray peaks related to that element. When two or more CRMs are used as reference, the concentration of each element can be determined by several different ways, either using more than one gamma ray peak for that element (when available), or using the results obtained in the comparison with each CRM. Therefore, determining the best estimate for the concentration of each element in the sample can be a delicate issue.

In this work, samples from several CRMs were irradiated together and the elemental concentration in one of them was calculated using the other as reference. Two sets of peaks were analyzed for each element: a smaller set containing only the literature-recommended gamma-ray peaks and a larger one containing all peaks related to that element that could be quantified in the gamma-ray spectra; the most recommended transition was also used as a benchmark. The resulting data for each element was then reduced using up to five different statistical approaches: the usual (and not robust) unweighted and weighted means, together with three robust means: the Limitation of Relative Statistical Weight (LRSW), Normalized Residuals (NR) and Rajeval (RT). The resulting concentration values were then compared to the certified value for each element, allowing for discussion on both the performance of each statistical tool and on the best choice of peaks for each element. The analysis of the Z-Scores and relative uncertainties obtained with each method shows that the best results are obtained using the recommended gamma-ray set and either the Normalized Residuals or the Rajeval techniques.