

Short Communication

Determination of potassium content in the B, C and D Corning reference glasses using gamma-ray spectrometry

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Dedicated to Professor Oleg V. Mazurin on the occasion of his 75th birthday

Potassium is an important constituent of historical glasses. The determination of potassium concentration frequently plays the basic role for the examination of technology and provenance of glass artefacts. The gamma ray spectrometry belongs to the group of nondestructive methods of determining potassium content. Papers [1 and 2] provide details of the determination of the element concentration in historic glasses. A short description of the analysis procedure presented in those papers is given below.

Potassium contains 0.0119 % ^{40}K , which is the only radioactive isotope of this element. The ^{40}K decays with a half-life of 1.28×10^9 years by an electron capture (10.5 % yield) and a beta particle emission (89.3 % yield). The maximum energy of beta particles is 1314 keV. The gamma ray energy of 1460.8 keV has a branching ratio 10.5 %.

The radiometric measurements were performed with the use of a gamma-ray spectrometer, which contained an HPGe detector with the resolution of 1.9 keV, and a relative detection efficiency of 92.4 % for a 1.33 MeV gamma line. The 10-cm passive lead shield lined with 0.5 cm cadmium and 0.5 cm copper was applied for reducing the natural background radiation.

The full examination consisted of two measurements. The first step included measurement of a silicon mould with the examined glass inside. For the second measurement, the same mould was filled with the powdered material that was used for calibration. High-purity K_2SO_4 was used for this purpose. The self-absorption effect was taken into account during the computation of results. The counting time of each measurement was 24 h.

For the validation of the analysis procedure applied, measurements of potassium concentration were made

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Table 1. K_2O contents obtained by gamma ray spectrometry compared to the values given in [4]

reference glass	weight of glass sample in g	K_2O in wt%	
		comparative value	gamma ray spectrometry
B	15.7	1.00	1.02±0.03
C	14.8	2.84	2.84±0.06
D	11.8	11.3	11.2±0.3

for a group of three reference glasses, Corning B, C and D¹⁾. The glasses were prepared for the Corning Museum of Glass, Corning, NY (USA) [3 and 4]. Laboratories in most countries very frequently use these reference glasses as comparison samples for chemical analyses of historical glasses.

Three measurements were made for each sample and for the calibration material. The reference glasses had the shape of a rectangular prism; their dimensions were approximately (20 x 18 x 13) mm³. The relative correction for self-absorption was determined and applied for the calculation of K_2O content [5].

The results obtained and recommended are listed in table 1. The results confirm the efficiency of the procedure applied for the determination of potassium concentration as well as the comparative values of potassium concentration in the reference glasses examined [4].

However, we should remember that in the case of complicated shapes of historical glass objects, it is difficult to make a correction for the self-absorption effect for the procedure applied. Moreover, there are additional factors, which can deteriorate the accuracy of analyses carried out using the gamma-ray spectrometry. These factors are difficulties in obtaining a uniform distribution of sulphate inside of a complicated mould

made of rubber. For simple shapes, the gamma ray spectrometry provides a very accurate determination of potassium concentration, which is confirmed with the results obtained.

References

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