Lab Report XRF 128

S2 PUMA

- Small-Spot Analysis with the S2 PUMA

Introduction

The S2 PUMA is the all-round instrument for elemental analysis and does not only perform excellent analyses of prepared samples such as fused beads or pressed pellets, but can also handle large bulk samples and run in-situ small-spot analysis of particular parts of a specimen (see Figure 1).

The non-destructive analysis of small particles is an important analytical technique with a wide range of applications. Many dedicated instruments have been engineered to master such applications. But all of them are specialized products and many

Figure 1: The S2 PUMA – the all-round EDXRF instrument

require a dedicated sample preparation. With the S2 PUMA, however, not more preparation than for any other XRF sample is required to obtain quick results.

This lab report will outline the analytical versatility of the S2 PUMA with regards to standardless small-spot analysis of a tooth, a bulk rock, and a tile.

Performance and Versatility paired in one Instrument: S2 PUMA

The S2 PUMA is the high-performing benchtop energy-dispersive X-ray fluorescence (EDXRF) spectrometer and it is the most versatile EDXRF instrument. For this lab report we used the S2 PUMA in its carousel configuration with an X-ray tube with Pd target and the XFlash® silicon drift detector (SDD). The S2 PUMA Carousel offers the largest sample chamber of all EDXRF instruments on the market with dimensions of max. 45.5 x 42.5 x 10.6 cm (see Figure 2). It can be equipped with a range of small-spot collimator masks (1 - 28 mm; see Figure 3) and an HD camera for sample documentation.

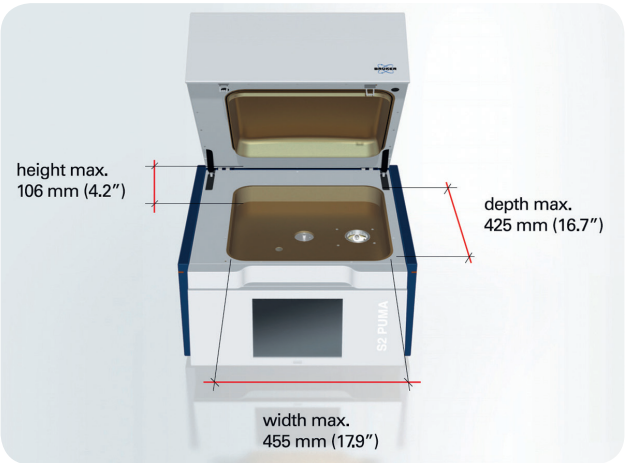

Figure 2: The S2 PUMA Carousel with the largest sample chamber on the market

The TouchControl™ interface allows for ergonomic spectrometer handling and the independent routine operation without any PC peripherals. The powerful instrument software suite SPECTRA.ELEMENTS guarantees intuitive use and highest analytical flexibility.

Figure 4: Metal-free ceramic dental crowns

Figure 3: Easily replaceable collimator masks in different sizes

Measurement Conditions and Set-Up

For this report we analyzed the enamel on a tooth, a crystal within a bulk rock sample, and a coloured tile. The samples were placed into the S2 PUMA's sample chamber as they are. With the help of the HD camera they have been placed so that the X-ray beam could illuminate the desired spot. All samples were analyzed under vacuum and have been evaluated with our standardless software plug-in SMART-QUANT FP. See Table 1 for detailed measurement conditions.

Sample	Voltage [kV]	Filter	Measurement Time [s]	Collimator Mask
Tooth, granitoid	20	none	1800	1 mm
	40	Al (500 µm)	1800	1 mm
	50	Cu (250 µm)	1800	1 mm
Tile	20	none	80	3 mm
	40	Al (500 µm)	80	3 mm
	50	Cu (250 µm)	150	3 mm

Table 1: Details on small-spot measurement conditions

Tooth Enamel Analysis

The enamel on a tooth specimen (approx. 1 x 0.5 cm; see Figure 4) was used as an example for a standardless small-spot measurement with the S2 PUMA. The small sample was placed in a liquid cup for the measurement, see Table 2 for measurement results.

P [wt.-%]	S [wt.-%]	Ca [wt.-%]	Ti [wt.-%]	Zn [wt.-%]
25.4	0.04	72.5	0.07	0.24

Table 2: Results of the standardless small-spot analysis of tooth enamel with the S2 PUMA

Figure 5: Black biotite crystal (cf. red arrow) within bulk rock sample

Small-Spot Analysis on Granitoid

Sometimes it is necessary to obtain whole rock and spatially resolved measurements on the same sample. Here the S2 PUMA really shines, because of its ability to non-destructively analyze small crystals within large bulk rock samples and, after preparation, get a whole rock analysis from the same specimen – all with the same instrument. Exchanging sample carousel and collimator masks is everything needed to switch between the two modes, and that is done within seconds.

Table 3 lists the standardless in-situ measurement results of a biotite crystal within a granitoid bulk rock sample (size approx. 10 x 5 cm; see Figure 5) obtained with the S2 PUMA.

Spatially Resolved Analysis of Coloured Tile

Heavy metals have been used in the past – and sometimes are still used – for dyeing. What makes for great colours is not necessary healthy. On the example of a coloured tile (see Figure 6) we demonstrate the S2 PUMA's ability to test spatially resolved for those elements to get a quick answer on what makes the colours.

Table 4 below lists the standardlessly obtained values for the brown, white, and blue areas of the sample. The measurement conditions are listed in Table 1. While the brown and white areas show similar values for Zn and Pb, the brown colour contains more Fe and less Mg and Zr compared to the white dye. The blue colour, however, shows elevated values for Co and Zn compared to numbers from brown and white areas.

Figure 6: Three-colour design tile

Na_2O [wt.-%]	MgO [wt.-%]	Al_2O_3 [wt.-%]	SiO_2 [wt.-%]	Cl [wt.-%]	K_2O [wt.-%]	CaO [wt.-%]	TiO_2 [wt.-%]	V_2O_5 [wt.-%]	MnO [wt.-%]	Fe_2O_3 [wt.-%]	ZnO [wt.-%]
0.11	9.94	15.18	39.40	0.10	7.64	0.27	3.08	0.17	0.54	23.05	0.11

Table 3: Standardless in-situ analysis of biotite crystal within granitoid sample

Sample Area	MgO [wt.-%]	Al2O3 [wt.-%]	SiO2 [wt.-%]	P2O5 [wt.-%]	K2O [wt.-%]	CaO [wt.-%]	Fe2O3 [wt.-%]	CoO [wt.-%]	ZnO [wt.-%]	As2O3 [wt.-%]	ZrO2 [wt.-%]	PbO [wt.-%]
Brown	1.9	11.5	62.7	2.9	2.6	6.2	10.4	0.0	0.2	0.0	1.2	0.3
White	7.5	8.5	66.2	0.0	2.1	6.8	0.2	0.0	0.3	0.0	7.6	0.2
Blue	0.2	12.5	72.0	0.0	3.3	7.5	0.1	0.9	2.9	0.0	0.4	0.1

Table 4: Standardless small-spot analysis results for the three dyes of the tile sample

Summary

The large sample chamber and the small-spot analysis capability together with the standardless evaluation with SMART-QUANT FP make the S2 PUMA Carousel the ideal all-round spectrometer to quickly screen samples of all size. Be it a small-spot analysis on a small specimen or an in-situ measurement on a larger bulk sample, the S2 PUMA handles all of those samples and obtains results non-destructively and without sample preparation. This makes the S2 PUMA the affordable multi-purpose elemental analyzer.

When it comes to versatility in elemental analysis there is no way around the S2 PUMA Carousel!

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Links

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