

Non-destructive LA-ICP-MS trace element studies on sapphires.

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Abstract

Laser ablation-ICP-MS is one of the preferred techniques for trace and ultra trace element determinations in solid materials. The greatly improved ablation behaviour of a homogenized 193nm excimer laser was used for "non-destructive" fingerprinting of sapphires. 97-99 wt% of sapphires are Al_2O_3 (Corundum) and the remaining few wt% consists of several trace elements, which can be used to distinguish the origin of such gemstones.

The ablation behaviour of different sapphires samples was studied to determine the minimum amount of sample removal necessary for trace element determinations. More than 40 isotopes were tested using different spatial resolutions (20-120 μm) and 8 elements were reproducibly detected in the 5 different sapphire locations selected for this study. The reproducibility of the trace element distribution was tested on several replicates on individual samples. The optimum ablation conditions were evaluated for the laser (180 mJ using a spatial resolution of 120 μm), which allows a sample uptake of approx. 100 nm per pulse. For quantitative analysis the linear dynamic range of the ICP-MS allows to use Al as internal standard element to correct the different mass ablated. The NIST 612 glass reference material was used as external calibration standard. The limit of detection for most of the low mass elements were in the ppm region and in the 0.01 ppm region for elements above mass 85.

Based on the quantitative data acquiring, the source of natural sapphires from different origins was proofed. Ternary plots and different statistical tests were applied to the data to classify the 5 origins. The applicability of LA-ICP-MS for routine analysis of sapphires and achieved the results will be extensively discussed.