

Chemical Fingerprinting as a Tool in Non-Destructive Gemstone Analysis

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Fingerprinting, i.e. identification and characterisation of individuals by means of objective and reproducible variables, is used in gemmology for identifying synthetic gemstones and the verification of gem origin.

Trace elements are used as variables, which have to be detected and quantified by means of non-destructive methods since valuable gemstones must not be damaged by any kind of inspection. In contrast to conventional wavelength-dispersive X-ray fluorescence (WD-XFA), energy-dispersive XFA is truly a non-destructive technique being able to detect and quantify chemical main components and trace elements (Z=11 to 92/Na to U) in inorganic solids like gemstones. Detection limits are matrix- and element-dependent, typically 20 to 200 ppm under normal conditions, for example Ti, V, Cr, Mn, Fe, Zn, Ga, Nb, Sn, in corundum matrix (ruby, sapphire).

A specific problem of gemstone analysis is crystallinity causing diffraction peaks, and the varying size of gemstones (in practice 0.5 to 50 ct). Careful filtering and collimation of the primary radiation are suitable counter-measures.

A fast and non-destructive trace element determination of gemstones is possible since 1983 when the technique was successfully introduced. Each evaluation has to consider, however, the impact of counting statistics on data quality.

Origin determination relies, furthermore, upon a sufficient quantity of data of analysed gemstones of known provenance (mine, locality), measured with the very same analytical hard- and software.