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An assessment of the potential benefits of ion implants as trace-element reference material for electron probe X-ray microanalysis: The case of invisible gold

Yves Thibault* and Allen R. Pratt

CANMET-MMSL, Natural Resources Canada, 555 Booth Street, Ottawa, Ontario K1A 0G1, Canada

Abstract

The reliability of trace element concentrations obtained by EPMA can be significantly improved with the use of high-quality secondary standards. In the case of Au residing in sulfides, such standards are lacking. Natural materials have heterogeneous Au distribution, whereas synthesis is very difficult. The benefits of using ion implants as trace-element reference material for EPMA were assessed by characterizing grains of magnetite, pyrite and galena implanted with 1×10^{14} to 5×10^{14} Au atoms/cm^2 at energies from 1 to 3 MeV. The first interesting observation is the excellent lateral micrometer-scale homogeneity of the Au levels across the implants. The ratio of analytical to statistical standard deviations never exceeds 1.7. Additionally, the Au X-ray intensities measured by EPMA show excellent correlation with those predicted for multilayered structures used to model the continuous Au concentration profile for the three implants investigated. Small discrepancies arise only at low accelerating voltage. In these situations, the predicted Au X-ray intensities become sensitive to uncertainties in the determination of the location of the Au concentration profile because of insufficient excitation of the bottom of the Au layer. Fortunately, by varying the implantation energy, optimal implants yielding X-ray intensities that are insensitive to uncertainties on the Au depth profile can be obtained for a wide range of accelerating voltages. These results suggest that ion implants may represent excellent EPMA reference material, especially in cases where natural and synthetic standards are unavailable. Interesting materials presenting specific analytical challenges can be engineered due to the excellent control of the implantation parameters.

Keywords: EPMA, ion implants, standards, trace element, Au