

Qualitative and Quantitative Analysis of Uranium in Ceramic Tiles Using Laser-Induced Breakdown Spectroscopy and Gamma-Ray Spectroscopy

Authors : Reem M. Altuwirqi, Mohja S. Summan, Entesar A. Ganash, Safia H. Hamidalddin, Tamer E. Youssef, Mohammed A. Gondal

Abstract : Laser-Induced Breakdown Spectroscopy (LIBS) technique using 1064 nm Nd: YAG laser was optimized and applied for investigating the existence of radioactive elements (uranium) in twenty-six different ceramic tiles. These tiles were collected from the local Saudi market. Qualitative and quantitative analysis for trace radioactive elements like uranium in these samples was achieved using LIBS. The plasma parameters such as temperature and electron density were calculated to confirm that the plasma generated by the tile samples under laser irradiation can be related to analyte concentrations. In order to perform a quantitative analysis, calibration curves were constructed for two uranium lines (U II (424.166 nm) and U II (424.437 nm)). The Uranium activity concentration in Bq/kg for each sample was measured. Cross-validation of LIBS results with a conventional technique such as Gamma-Ray spectroscopy was also carried out for five ceramic samples. The results show that the LIBS method is an effective way of determining radioactive elements such as uranium in ceramic tiles. Moreover, the uranium concentrations of the investigated samples were below the permissible safe limit for building materials in the majority of samples. Such LIBS system could be applied to determine the presence of natural radioactive elements in ceramic tiles and their radioactivity level rapidly to ensure that they are under the safe allowed limit.

Keywords : laser-induced breakdown spectroscopy, gamma-ray spectroscopy, natural radioactivity, uranium, ceramic tiles

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