Impurities characterization in Brazilian Natural Emerald

F. Ayres[1*], G. B. Silva[2], R. G. Brasileiro[3]

[1]*ICEN/CUR, Universidade Federal de Mato Grosso, Rondonópolis, MT, Brazil*
[2]*ICET/CUA, Universidade Federal de Mato Grosso, Barra do Garças, MT, Brazil*
[3]*IF, Universidade Federal de Mato Grosso, Cuiabá, MT, Brazil*

Besides being commonly used as ornamental jewelry, emeralds are used in applications that require the combined properties of an electrical insulator, excellent heat conductor, with high strength, hardness and very high melting point. In this work, the emerald, green beryl, which composition is represented by $Be_3Al_2Si_6O_{18}$, has been investigated in order to analyze its dielectrical properties and which impurities are responsible by the different shades (greenish-clear, greenish-average and greenish-black). The samples from the same batch were brought from Socotó (Bahia, Brazil). The measurements were performed in all set of samples by FTIR, X-Ray fluorescence and electrical impedance spectroscopy (EIS). The ohmic contacts of Ag were evaporated onto polished surfaces to obtain the EIS spectra. It was observed stretching vibrations of water in 3500 to 3700 cm^{-1} region in the FTIR spectrum of natural emerald. These bands can be related with water free and bound to alkaline metals impurities. Impurities in the three samples were characterized by X-Ray fluorescence investigations. It was observed Ca and Rb, which can justify different water vibrations band positions in FTIR spectrum. It was also observed Cr in X-Ray fluorescence spectra. As expected, the greater the amount of Cr, greener is the sample. In the EIS, it was observed that the increase of electrical field is not enough to induce permanent electrical dipoles in the sample. In the same way, there can be a distribution of relaxation times related to the several electrical dipoles. A simple electrical circuit, which contains parallel resistor-capacitor and a constant phase element (CPE), was suggested to simulate the spectra. The observed phase angle was 0.67 and it is believed that the CPE comes from non-uniform current distribution.

Keywords: emerald, beryl, impurities, color centers, electrical behavior.

[1] D. L. Wood and K. Nassau, Am. Mineral. **53**, 777 (1968).
[2] R. R. Viana, H. Jordt-Evangelista, G. Magela da Costa, and W. B. Stern, Phys. Chem. Minerals **29,** 668 (2002).
[3] B. A. Kolesov, C. A. Geiger, Phys. Chem. Minerals **27**, 557 (2000).

[*]Corresponding author:
ICEN/Campus Universitário de Rondonópolis/UFMT, Rod. MT 270 km 6, Rondonópolis - MT, Brazil, CEP 78735-910.
E-mail: frederico.ayres@gmail.com