Activation energy of annealed, fully metamict samarskite determined with ^{57}Fe Mössbauer spectroscopy

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Sample description

Samarskite is a complex Nb-Ta-Ti-REE + Y-Ca-U-Th multiple oxide that contains iron, and other elements. Samarskite has always been found to be completely metamict [1]. Due to its chemical complexity and metamictization, the chemical formula and crystal structure of samarskite have not been unambiguously characterized [2]. This study used ^{57}Fe Mössbauer spectroscopy to determine the activation energy for the thermal recrystallization of a fully metamict specimen of samarskite-(Y) after annealing for 1 h in argon, at 473 to 1373 K. The sample was collected from a granitic pegmatite in Centennial Cone, Colorado (USA). The uranium and thorium concentrations corresponded to a calculated total absorbed α-dose of 6.5 x 10^{17} α-decay mg^{-1}.

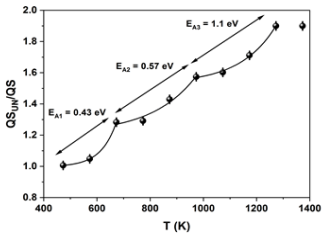

Figure 1: Variations in the quadrupole splitting (QS) values of the Fe^{3+} component with annealing temperature (T). QS_{UN} is the value of QS for an untreated samarskite sample.

Results

The Mössbauer spectrum of the untreated samarskite sample was characterized by two quadrupole doublets assigned to Fe^{2+} and Fe^{3+} in octahedral positions. Changes in selected experimental parameters observed in the Mössbauer spectra after annealing are sensitive indicators of the thermal recrystallization process. These changes revealed three stages of structural recovery from: 473 to 673 K, 673 to 1073 K, and 1073 to 1273 K. The activation energies associated with these temperature ranges were: 0.43, 0.56, and 1.1 eV, respectively (Fig. 1). These observations were consistent with X-ray powder diffraction patterns.

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[1] Sugitani et al. (1985) *Am. Mineral,* **70**, 856-866. [2] Warner & Ewing (1993) *Am. Mineral,* **78**, 419-424.