Thermal annealing of radiation-damaged allanite-(Ce): Mechanical and structural properties

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The mineral allanite-(Ce) with the ideal formula $^{A1}(Ca)^{A2}(REE)^{M1,M2}(Al)_2{}^{M3}(Fe^{2+})[SiO_4][Si_2O_7]O(OH)$ is a member of the epidote- supergroup [1] and can incorporate up to 5 wt% ThO_2. The incorporated thorium leads to structural damage through α-decay, while thermal annealing can reestablish the structure. Allanite is an interesting example for actinide contaminated materials as structured OH^- groups are assumed to act as a catalyst in the recrystallization process [2].

In this study different allanite-(Ce) samples with varying degrees of damage have been investigated. Combined results from nanoindentation, DSC/TG-MS, synchrotron single-crystal X-ray diffraction and Mössbauer spectroscopic measurements reveal a detailed picture of the structural response to step-wise thermal annealing [3]. It is shown that the recrystallization process starts below 700 K and causes an increase in the mechanical properties (hardness and elastic modulus). The sample with the highest OH^- content showed enhanced recrystallization behavior. Along with the loss of structural water, the iron oxidizes. A preferred iron position in the crystalline material could be determined [4].

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