

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

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The mineral allanite-(Ce) with the ideal formula  $A^1(Ca)A^2(REE)^{M1,M2}(Al)_2^{M3}(Fe^{2+})[SiO_4][Si_2O_7]O(OH)$  is a member of the epidote- supergroup [1] and can incorporate up to 5 wt% ThO<sub>2</sub>. The incorporated thorium leads to structural damage through  $\alpha$ -decay, while thermal annealing can reestablish the structure. Allanite is an interesting example for actinide contaminated materials as structured OH<sup>-</sup> 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<sup>-</sup> 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].

[1] Bonazzi, Holtstam, Bindi, Nysten, Capitani (2009) *Am Mineral* 94:121–134 [2] Zhang, Salje, Malcherek, Bismayer, Groat (2000) *Can Miner* 38:119–130. [3] Reissner, Bismayer, Kern, Reissner, Park, Zhang, Ewing, Shelyug, Navrotsky, Paulmann, Škoda, Groat, Pöllmann, Beirau (2019) *Phys Chem Mineral* 46:921–933. [4] Reissner, Reissner, Kern, Pöllmann, Beirau (2020) *Hyperf Interact* 241:18