American Mineralogist, Volume 102, pages 1066–1072, 2017

Dry annealing of metamict zircon: A differential scanning calorimetry study

Robert T. Pidgeon[1,*], Peter G. Chapman[2], Martin Danišík[1], and Alexander A. Nemchin[1]

[1]Department of Applied Geology , Curtin University, Bentley, Western Australia 6102, Australia
[2]Department of Chemistry, Curtin University, Bentley, Western Australia 6102, Australia

Abstract

We report the results of a differential scanning calorimeter (DSC) study of the annealing of a metamict Sri Lankan zircon. Raman measurements on most chips of the powdered zircon starting material, Sri Lankan zircon (WZ19), showed no evidence of a crystalline structure, whereas a few chips retained residual Raman bands typical of highly radiation damaged zircon. DSC runs on aliquots of the powdered sample were heated to 850 and 1000 °C at rates of 2 and 10 °C/min and to 1500 °C at a rate of 10 °C/min. Raman spectroscopy was used to investigate the crystallinity of grains at selected temperature stages. Exothermal peaks were observed at about 910 and 1260 °C during the DSC run to 1500 °C. The 910 °C peak was demonstrated by Raman spectroscopy to mark the crystallization of tetragonal zirconia and the exothermic peak at about 1260 °C was demonstrated to represent the reaction of zirconia and amorphous silica to form crystalline zircon. The degree of crystallinity of these grains was almost identical to that of highly crystalline zircons from recent gem gravels from New South Wales. A small number of experimental chips from DSC analyses under 1000 °C were found to have zircon Raman bands that indicated they had undergone partial annealing. The present experimental results suggest that reconstitution of amorphous zircon to the crystalline state by dry annealing will rarely occur in terrestrial geological settings, even under extreme metamorphic conditions.

Keywords: Radiation damage, metamict zircon, radiation damage annealing, differential scanning calorimeter, zircon Raman spectra