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SAXS study of etching behavior of ion tracks in apatite

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Ion tracks consist of narrow (~10 nm), long (~10-100 μm) cylindrical defect regions that are generated by high-velocity heavy ions when they pass through a variety of solids. Such tracks result naturally from fission of uranium inclusions in minerals such as apatite and zircon and are used for determining the age and thermal history of geological material. This so called 'fission track dating' technique utilizes chemical etching to enlarge the tracks to micrometer widths, which enables imaging by optical microscopy and subsequent statistical analysis of their number and length distributions.

The present work investigates how differences in the un-etched track morphology translate into etched ion track dimensions. Tracks were generated by irradiation of the samples with 185 MeV Au ions and 2.3 GeV Bi ions. The morphology of etched and un-etched tracks was studied using synchrotron based small angle x-ray scattering (SAXS) and microscopy techniques such as scanning electron microscopy (SEM) and atomic force microscopy (AFM). Additionally, track annealing was investigated using SAXS in combination with ex-situ annealing experiments performed prior to chemical etching. Results indicate, that the etching process is highly anisotropic, yields faceted etch pits and depends on the mineral composition. These results provide important input to develop an understanding of the correlation of etched and un-etched fission tracks and the use of SAXS as a tool for studying etched tracks.

Keywords or phrases (comma separated)

Ion track, etched, unetched, SAXS

Summary

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