Atomic force microscopy of fission tracks in fluorapatite and mica: a tool for nanoscale investigations

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We report an approach to obtain new insights into fission track development and its etching behaviour close to the nanoscale in fluorapatite and mica using an Atomic Force Microscope (AFM). In the present work, fission tracks were implanted in mica and fluorapatite using a 50µCi ^{252}Cf source and imaged with an AFM.

The use of a TEM for examination of tracks formed by fission particles can be problematic, because high energy deposition by the electron beam may anneal tracks during measurement [1]. The advantage of an AFM is that no heat is produced and it can be used on both conducting and non-conducting surfaces. If the sample is observed in the non-contact mode then no physical damage is imparted to the atomic scale surface of the sample. Combining the measured data with topographic information, allows x, y and z coordinates to be obtained, and these can be used to build up a three-dimensional digital elevation model of the scanned area. Recently, some researchers have applied the AFM to study etched tracks in solid-state nuclear track detectors [2].

In our work we studied unetched fission tracks in micas and fluorapatite. It was found, that fission track openings are crater-like structures in the mineral surface with diameters between 16-28 nm. Some openings have a pronounced raised rim that may represent the region of strained lattice around the track core.

Another nanoscale application we present using the AFM is a new approach for determination of the bulk etching rate for fluorapatite as well as its fission-track etching efficiency. As our methodological approach is refined, AFM measurements of the damaged trajectories of fission particles in fluorapatite and mica should prove to be a useful tool for the nanoscale investigation of fission tracks in minerals, leading to improved understanding of their use in fission track thermochronology.

References

[1] Paul T.A. and Fitzgerald P.G. (1992) *American Mineralogist* **77 (3-4),** 336-344.
[2] Nikezic D. and Yu K.N. (2004) *Materials Science & Engineering R-Reports* **46 (3-5)**, 51-123.