X-ray Enhancement of Etch Parameters of Nuclear Tracks in CR-39

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Motivation

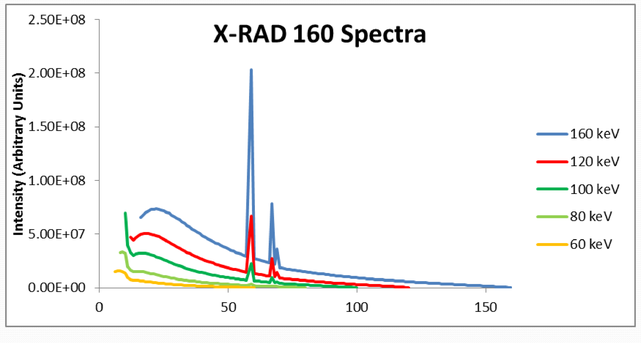
CR-39 is a polymer track detector used by the Laboratory for Laser Energetics (LLE) in Rochester to detect charged particles produced in inertial confinement fusion (ICF) experiments. Incident charged particles cause damage sites to form on the surface of the polymer. These damage sites are etched to the micron scale with NaOH. However, for recent batches of CR-39, background features in the polymer create false signals that create problems for automated analysis.

By exposing samples of CR-39 to x-rays prior to etching, the size of the damage sites is enhanced during the etching process.

d_{ave} = 22.60±.66 μm

d_{ave} = 25.2 ±1.4 μm

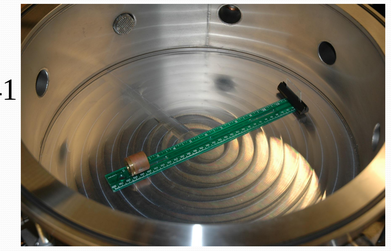
With larger, more defined pits, the signal to noise ratio can be increased, improving the conditions for the automated systems.



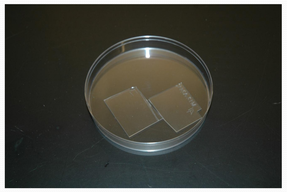
The samples were exposed to x-rays produced by the X-Rad 160 Biological Irradiator.

Procedure

Samples of CR-39 are irradiated with alpha particles from an Am-241 source for two hours a 30mT vacuum.



The sample is then broken in half and each piece is scored with either an “A” or “B”



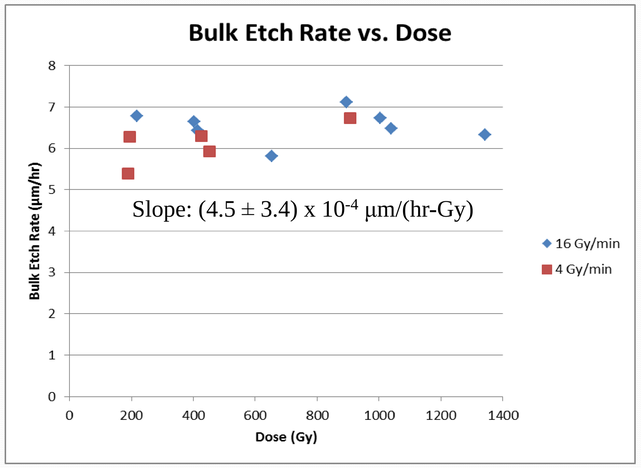
Side A is exposed to x-rays and the dose is measured while Side B is stored at STP

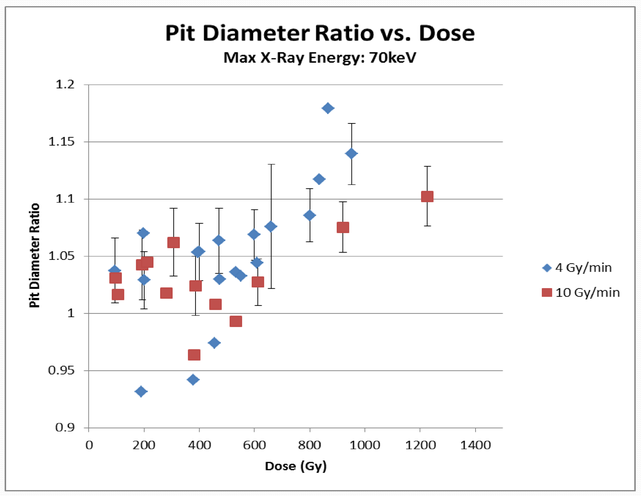
Both pieces are etched in 6N NaOH for six hours at 80°C in the same beaker. Then they are both rinsed with tap water and air dried overnight

Once the sample is dried, pit diameters are measured using a petrographic microscope.

The Pit Diameter Ratio is defined as the average pit diameter for the x-ray irradiated piece (A) divided by average pit diameter for the control piece (B).

Results





Our results showed little correlation between bulk etch rate and x-ray dose; however, pit diameters increased with increasing x-ray dose. The enhancements measured were modest; only a 10% increase in pit diameter was observed after an x-ray exposure of over 3 hours.

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