EN-21 Alpha Particle Recording Film

Introduction

These films are solid nuclear-track detectors designed for the dosimetry of ionizing particles. They are primarily used to detect alpha particles but they are also sensitive to other heavy ions. They have no sensitivity to electrons, light, X-rays or other gamma rays, so they are quite convenient to use. All work can be done in a fully lighted room. The EN-21 is supplied as a 18.6 cm disc to fit into the EN-20 Rutherford Scattering Apparatus.

The film consists of a thin layer (12μm) of cellulose nitrate, colored deep red and coated on a 100μm thick polyester base. Only the side of the film with the red coating is sensitive. When an alpha particle strikes the surface of the film, the structure of the cellulose nitrate is damaged, such that when developed, the film is etched away in the vicinity of the spot. This leaves a clear area in the red film which is easily visible with the naked eye. Contrast is improved if the light source used to view the processed film is filtered with a green filter.

The exposed spots can be counted using a binocular microscope with 20 - 40 x magnification. Another alternative is to place the processed film in a slide projector and project the image onto a screen. The spots are counted on the screen. Another useful method of evaluating the exposure is to place the film in a photographic enlarger and make a high contrast print of the image. This method has the added advantage of providing a readable file copy of the exposure. The recording film itself is NOT suitable for archival use. It is recommended that enlarged photocopies be made of the films for file use and the original films discarded.

This film is a flammable material with an auto-ignition temperature of 180°C.

Processing

The tracks detected by this film are not directly visible, but have to be intensified by processing the film in an alkaline bath. The recommended etching agent is a 10% (2.5N) solution of caustic soda (Sodium Hydroxide), of analytical purity, in distilled water. The recommended temperature of the etch bath should be controlled and held at 40°C. The bath temperature can be maintained by placing the film in a beaker containing the etch solution in a laboratory oven set to 40°C and covering the beaker with a watch glass.

A short etch time results in tiny, hard to see holes. A long etch time makes the holes much more visible but will cause them to run together if the exposure is very high. For best results, leave the film in the etching bath for about 24 hours without agitation. The film sloughs off part of its thickness in the etch bath resulting in red material floating in the bath. This is normal and rinsing the film should remove this material before the film is dried.

Procedure

1. Expose the film. For the EN-20 Rutherford Scattering Apparatus, a typical exposure time is 7 days. Remember that alpha particles have a very limited range in air, so the apparatus must be evacuated during the exposure.
2. Make up the developer solution. Analytical grade 2.5 N Sodium Hydroxide is available from chemical supply houses and may be more convenient than dissolving Sodium Hydroxide pellets in distilled water. Keep the solution covered when not in use to avoid evaporation and carbonation. Sodium Hydroxide, particularly at higher temperatures, will dissolve carbon dioxide from the air to form the less-alkaline Sodium Carbonate.
3. Place the covered etch solution in an oven set to 40°C and let its temperature stabilize.
4. Place the exposed film in the beaker. The etch solution should **not** be agitated during development. Cover the beaker and return it to the oven.

5. Leave the film in the etch for 24 hours.

During the etching process, the removed coating forms a dirty looking sediment in the solution. This is perfectly normal. Judge the completion of development by the look of the film, not by the look of the developer. A correctly processed film has a lighter color than before processing, but is still quite reddish in color. When developed too long, the color of the coating becomes very pale and the particle marks will be lost in the low contrast background.

6. Remove and rinse the film in running water at 40°C for 30 minutes.
7. Rinse the film in an ethyl alcohol/distilled water (1:1) solution for about 2 minutes at 40°C. This step reduces the chance of water spotting during drying and is not strictly necessary.
8. Dry the film.

Photographic processing film clips and holders are very useful in processing the film without damage. They are safe to use in the etching solution and a great help when drying the film.

A test strip of film is enclosed with the circles in the EN-21 package. To verify that exposure and processing conditions are correct, a sample exposure can be made on a test piece.

Test Exposure

This test requires the removal of the Po-210 Source from the back of the Rutherford Scattering chamber to use as an exposure source of α particles.

1. Remove the five screws holding on the end piece of the chamber. Reach inside and hold the collimator assembly. If your hand will not fit through the aperture, find a young assistant with smaller hands. Don't touch the gold film at the front of the collimator. Don't blow on it to remove dust. It will break with the slightest provocation.
2. Undo the two screws on the outside rear of the chamber. This will release the collimator-source assembly. Remove it from the chamber.
3. The Po-210 Source sits in a pocket in the rear of the collimator. Remove it.
4. Cut about 1.5cm square from the test film and tape it over the well in the plastic disc Source. It is important that the active side of the film faces the source. The film normally has a slight curl and the sensitive layer is on the inside of the curl. To be absolutely sure, scratch the film surface with a razor blade. The active side will scratch to clear. The film support side will not go clear.
5. Replace the collimator without the source into the chamber. Tighten the two holding screws.
6. Lay the Source and film in the bottom of the chamber and replace the end cap.
7. Attach a vacuum pump and pump down the chamber. When the air is gone the α particles will reach the film surface and start to expose it. Leave the vacuum on for 30 minutes.
8. Open the chamber and remove the Source and film. Process this film sample as recommended above.

Since the Source is so close to the film, there will be a heavily exposed area on the film. It should be almost clear in the center but will shade off towards the edges. Examining this area should show countless tiny clear spots due to the α particle exposure. If you have achieved this result in this test, continue with the Scattering experiment. If not, repeat the test to find where the trouble lies. The Scattering experiment exposure time is too long to waste it on faulty processing.