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Non-etching optical detection of fission tracks using Teflon

THE detection of tracks in material irradiated by charged particles, has been accomplished using electron microscopy[1] and etching followed by optical microscopy[2-6]. We have attempted to detect unetched tracks using optical microscopy. Presumably, unetched tracks retain more information about the radiation than is retained after etching.

The kinds of damage which can be caused by the passage of a charged particle through any material are bond ruptured, which produces free radicals[7], physical dislocations, as in the Wigner effect in reactors in which carbon atoms in graphite are displaced by fast neutrons, and certain other less obvious but more visible effects such as the production of metastable states which emit light, as in thermal luminescence and scintillation counters.

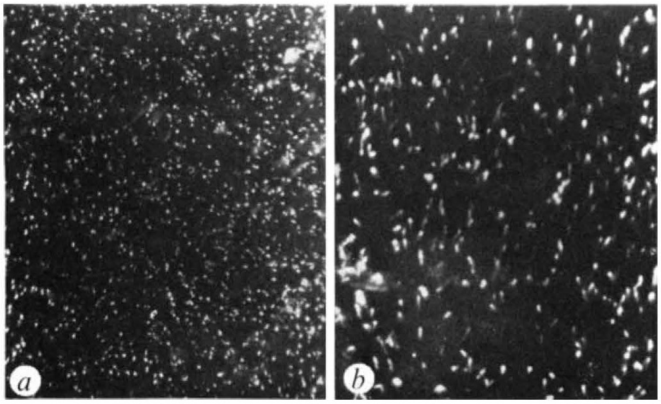
It seemed possible that, in order to obtain the best record of the track itself, a material and detection process could be used which would minimise the general background and make possible the direct observation of the track itself using an optical microscope. So we chose, following the work of others[8-12], to use cross linkage copolymerisation of radiation-damaged polytetrafluoroethylene, Teflon, with acrylic acid monomer followed by dying with the basic dye Rhodamine B which phosphoresces in orange under exposure to blue light. Teflon is one of the most chemically resistive materials known and should give essentially no background.

Teflon plastics films (51, 127, and 762 μm thick) were irradiated in air with fission products from a 50 μCi ^{252}Cf source for 1–2 min at room temperature. The samples were then inserted into glass tubes containing acrylic acid solution and degassed by freezing and pumping the system several times. After degassing, a grafting reaction with the free radicals in the tracks was allowed to continue in the absence of air at controlled temperatures (23–40 °C), for varying times (5–30 h). Good grafting was obtained at 23 °C after 25 h or at 40 °C after 5 h. We were also successful in getting good grafting results when the reactions were carried out in a dry nitrogen atmosphere. In these experiments dry nitrogen gas was bubbled through the acrylic acid solution for 15 m and then the tube was closed. Grafting occurred in dry nitrogen under conditions similar to those used in the evacuation experiments.

The solution was 50% vacuum distilled acrylic acid ($CH_2.CH.COOH$). After the grafting, the Teflon samples were washed thoroughly in deionised water at 50 °C for 2 h. Following this they were dyed with a boiling 3% solution of Rhodamine B for several hours and then washed for 15 min in a 2% acid soap solution to remove any unfixed dye. This procedure was apparently successful: the basic dye fixed itself to the acidic polymer that was attached to the damaged area of the Teflon.

Finally, the samples were examined with a Reichert-Austria Zetopan microscope fitted with an ultraviolet lamp. Rhodamine B phosphoresces with an orange colour when illuminated with light at a wavelength of 400 nm. A cutoff filter eliminated the excess blue light which produced a dark field, and the fission tracks then appeared as bright lines (Fig. 1*a* and *b*).

Fig. 1 Tracks of fission fragments. *a*, × 180 diameters; *b*, × 360 diameters. Made by grafting acrylic acid on to Teflon. The apparent length of each track is related to the angle of its inclination.



It seems possible that more information can be obtained from tracks developed and measured in this way and that Teflon treated like this may well be useful in the future detection of tracks formed by the passage of charged particles.

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Rapid hydrogenation of sterols in a contemporary lacustrine sediment

THE steroid carbon skeleton has been widely used as an indicator of biological origin of the organic material in ancient sediments[1-3] and petroleum[4]. Sterols, presumed precursors of the geolipid steranes, and stanols, their saturated analogues, have been identified in Recent[5-7] and ancient[8,9] sediments. In view of their generally low abundance in living