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Ion track filters have enormous application potential in medicine, microelectronics industry for pollution control. A new field of micro/nanotechnology has come into vogue. An overview of production and applications of ion track filter is given.

Ion Track Filters : An Overview of Production and Application

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Introduction

Ion track filters (ITFs) are produced by physicochemical treatments to thin films of polymers and mica irradiated by heavy ions. These ion track filters have many applications in the fields of science and technology, like microhydrodynamical flow studies, conduction of bacteria and blood-cells, development of metal and metal-semiconductor microstructures, etc. During the past several years various new micro-porous membranes and filters have been developed for use in the field of science and technology, viz., health, medicine, air pollution, beverage industries, development of microtubles, material science characterization, etc.. These filters are generally made from polymeric materials, ceramics and minerals. The technique that led to the development of etched track membranes was first discovered by Price and Walker[1] in USA. They found that the damage trails in insulating materials caused by ionization as a result of the passage of travelling charged particles can be revealed by the chemical etching to form the cylindrical pores. They observed the fine pores due to fission fragments in 12 µm thick length. Heavy ion accelerators are promising alternative for generating these filters.

In order to produce ion track filters thin sheets of plastics are exposed to a collimated beam of particles from an accelerator having different energies. When heavy charged particles pass through these thin foils they produce continuous damage along their path and thus leave behind a train of radiation damaged material. The chemical etching of these irradiated foils leads to the formation of fine hollow channels along the path of the charged particles due to preferential etching along the latent trail. If the thickness of the sheet is less than the particle range in it, the above process leads to the formation of the fine pores in the irradiated sheet (the basic outlines for the production of pores in membrane is shown in Fig 1). The porosity of these membranes can be controlled by the flux of the ion beam and pore diameter can be controlled by ion characteristics and etching parameters like etching time, etching temperature and

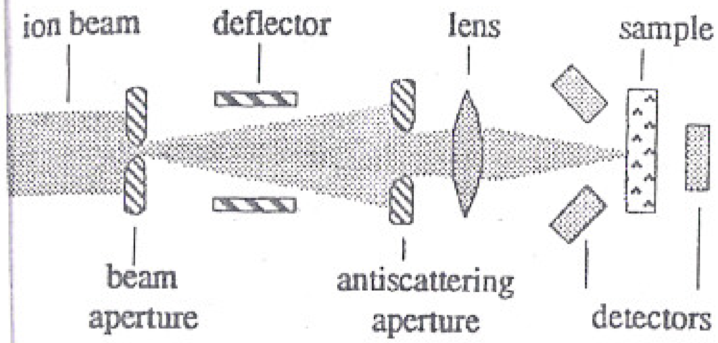

Fig. 1 : Ion microbeam device

etchant concentration, etc. Filters of diameter from 50°A to a few microns can be produced by this method in minerals and various plastics[2]. Ion track filters are mainly divided into two categories : (a) singlepore filters, and (b) multipore-filters. Singlepore track filters can be produced from the accelerator by controlling the beam optics and fluence of the heavy ion beam.

Materials for Production of Ion Track Filters

Materials used for the production of single and multipore ion track filters are tabulated in table 1.

The samples of various polymer films and mica have been irradiated by different heavy ion beams from the UNILAC accelerator at GSI, Darmstadt, Germany. The irradiated films were etched in typical solutions under different etching conditions mentioned in table 1.

Applications of ITFs

ITFs or Ion track membranes have been used for various microhydrodynamical studies, like separation of cancer cells from blood, characterization of submicron particles in human blood, filtration of microparticles from liquid and gaseous media, purification of aerosol particles in the atmosphere of industrial plants, etc. We have used ITFs for study of solute-solvent interaction by measuring the flow rates of two miscible solutions at a constant pressure.[3]

Table1. Some ion track recording films with typical etching conditions used for production of ITFs

Material	Etching condition
Makrofol (N, KG, SKG)	5.0–7.0N NaOH at 40–70° C
Kapton-H& F $[C_{22}H_{10}O_5N_2]_n$	(a) 1.0 N KOH in 80% ethnol and 20% H_2O (b) Sodium Hypochlorite (NaOCl)
Polyvinylidene fluoride (PVDF, CH_2CF_2)	5–10 N NaOH
CR-39 $(C_{12}H_{18}O_7)$	6.25N NaOH at 70°C
Lexan polycarbonate $(C_{16}H_{14}O_3)$	5.0–7.0N NaOH at 50–70°C
Muscovite mica	48 vol% HF at 23°C
Cellulose nitrate	2.5–5.0N NaOH at 40–60°C

ITFs are used for characterization of bacteria and blood cells. A conductivity cell (Fig.2) is used for the purpose. The water-borne bacteria, viz, E coli and C Bacillus are filtered by using multipore ITFs of 5 μm pore diameter. Other important applications in medical field are investigation of erythrocyte deformability and separation of blood plasma known as *plasmapheresis*. We have used ITFs for purification of drinking water and sizing of

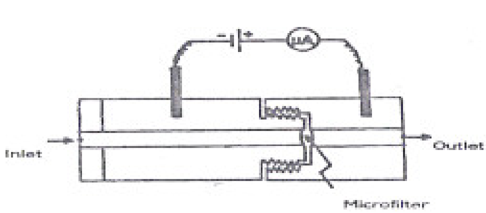

Fig. 2 : Block diagram conductivity cell

bacteria which causes gastroenteritis. It is observed that blood cells have the property of deforming their shape while passing through pores whose diameter is less than the size of blood cells.[4]

ITFs have found an interestng application in development of metal and metal-semiconductor microstructures in the area of microelectronics and micromechanics. A new field of nanotechnology has opened up with development of materials having exotic properties at nanodimensions. The methodology for development of microstructures is based upon the earlier work of Possin[5], Penner and Martin[6] producing thin metal wires of micron size. Using ITFs, microstructures of various sizes, shapes and microdimensions have been fabricated, viz. quantum dots, fibrils, cones, tubules and whiskers, etc. These devices find applicatins in field emission electrodes, electrochemistry, laser technology, superconductivity and microbiology. Track membranes coated by a metal are used as diffraction filters in ultraviolent rays and collimation and attenuation of electromagnetic radiation fluxes.

The last but not the least, ITFs have found application in pollution control. Air is freed of aerosol particles by passing through track membranes and then used in laboratories engaged in development of microelectronic devices. ITFs are also used for supply of clean, bacteria-free, unpolluted water in drug manufacturing units and hospitals. They can also be used for desalination of sea water by reverse osmosis and purification of aviation fuel used in aeroplanes.

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