Industrial Applications of Nano-Track Etched Templates and Films

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ABSTRACT

it4ip is a new spin out from the Université catholique de Louvain (Belgium) dedicated to the development and production of unique templates based on the combination of ion track technology of polymers. It supply customers with hi-tech products, state-of-the-art research and product development services with template capability to make high value added nano-objects, nano-structures and smart membranes. *it4ip* is engaged in collaborative applications-oriented research with customers to develop novel applications and markets for the technology.

Keywords : track, etch, technology, industrial, application

1. INTRODUCTION

At the 'Unité de physique et de chimie des hauts polymères', the track etching technology was originally developed and patented in the mid-eighties. For the past 15 years this *first generation* technology has been the basis for the commercial manufacture of porous polymer membranes used mainly for separation applications. Since the mid-nineties Professor Legras's team has been involved in several collaborative R&D projects supported by European and Regional Government fundings. Resulting major improvements in the track etching technology provide a tool kit of complementary techniques for making nano-templates for a wide variety of applications : the *second generation* technology based materials.

2. TECHNOLOGY & PRODUCTS

Track etching technology is based on the irradiation of polymer materials with energetic heavy ions leading to the formation of linear damaged tracks across the irradiated polymeric layer or film. These tracks are then revealed into pores using a well-chosen wet chemical etching.

Track etching technology of first generation is mainly used for the production of self-supported membranes made of polycarbonate (PC) or polyethylene terephthalate (PET) with randomly distributed pores. Typical membrane thickness is between 10 and 20 microns and pore size is in the range 0,1 µm to 10 µm.

Second generation track etching technology overcomes many of limitations and offers new advantages :

- true nanopores down to 10 nm with well-controlled pore shape in a large range of pore densities;
- use of polymer (polyimide-PI) resistant to high temperature (up to 430 °C)
- ability to track etch a thin polymeric layer deposited on a substrate such as glass, quartz, silicon, oxides, ... ;
- ability to confine nanopores into zones as small as 10 micron square (patterning process).

This second generation technology, when applied to larger pore size, also contributes to a better membrane with potential benefits as e.g. a more precise cut-off. Moreover, it leads to a better control of both pore size and pore shape reproducibility.

Current track-etched templates of 2nd generation are available in polycarbonate, PET & polyimide (http://www.it4ip.be/html/2006/products.htm).

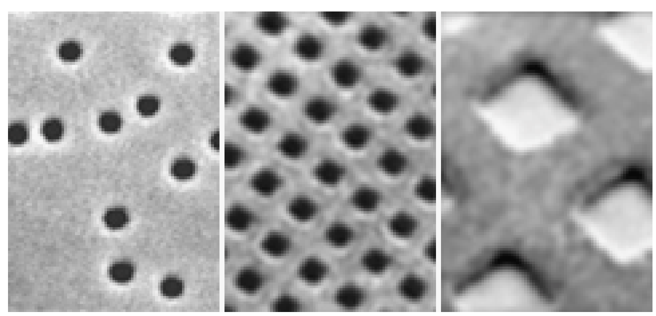

Figure 1 : from smart track etched membrane (left) to supported and patterned track etched templates (middle and right) – SEM pictures

3. APPLICATIONS

Smart membranes are used as separation barriers and flow controllers in devices such as chemical and biochemical sensors and analysers (lab on a chip, microtitre plates, ...).

For example, a specific track etched membrane has been designed to be used as a selective separation barrier in a project intends to develop, improve and validate an efficient reliable bioartificial pancreas for human application. The use of track etched membrane is also actually considered in a project intends to develop a controlled drug release system for biomedical applications including implanted cuff electrodes for both recording and stimulation of peripheral nerves.

The polymeric materials containing collections of engineered pores are employed as templates for the in-situ preparation of metallic or organic nano-objects used as electrodes, interconnects, tips (field emission, …), sensing elements (magnetic, chemical, biochemical, …), …

A variety of materials (metals, semiconductors, oxides, heterostructures) can be deposited into the pores as nanowires or nanotubes; these structures can be produced with over wide range of aspect ratios with excellent shape control, and can be either used in-situ or easily harvested by simple chemical dissolution. Property discontinuities in these nano-objects arising from the nanoscale dimension have been identified (microwave absorption in arrays of magnetic nanowires, charge transport and light extraction mechanisms of luminescent polymers, …), and confinement offered by these track etched templates is useful to design nano-structured devices like e.g. microfluidic devices for use in bio-analytical methods, circulators operating at frequencies in the range 22 to 77Ghz, elements for new low cost positioning systems in automotive applications, …

Track etched templates are also considered in the development of an innovative low cost technologies for the mass production of nano-structured high temperature superconducting materials based on chemical solution processing. The purpose is to achieve an artificial network of nano-defects that will immobilize the superconducting vortices and, hence, allow the achievement of high critical currents and weak magnetic field dependence in films and coated conductors with high thickness.

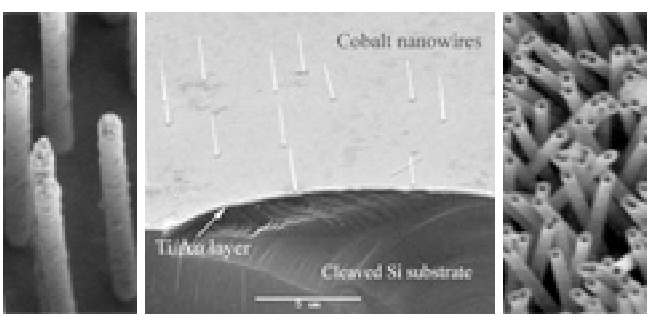

Figure 2 : metallic nanowires (left) and polymeric nanotubes (right) synthesized into pores of track etched membrane; metallic nanoscale tips upright on a Si wafer for field emission application (middle) – SEM pictures

4. CONCLUSIONS

Progress made in track etching technology can be benefit for the development of specific templates and for their integration into sub-elements of nanosystems.

Our interest is to be engaged in collaborative applications-oriented research and to supply nano-structures and nano-objects into market applications in the healthcare, energy, electronics, telecommunications and transport sectors.

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