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MICRO-CAPILLARY FILMS

A manufacturing process for embedding multiple parallel micro-capillaries into flat, flexible polymer tapes and films has been developed. Application areas include chemical and biochemical analysis, medical applications, heat exchangers and pressure sensing applications.

The shape and size of these micro-capillaries can be easily controlled, ranging in diameter from 5 to 500 microns, and having circular, elliptical or diamond cross-sections, allowing transport of liquids or gases at pressures as high as 50 bar. The capillary walls can also be designed to be semi-permeable or catalytic.

Key benefits of this process include:

- Simple control of shape and size of micro-capillaries providing circular, elliptical or diamond cross-sections with diameters ranging from 5 to 500 microns
- Transport of liquids or gases at pressures as high as 50 bar
- Option of catalytic capillary walls
- Option to create a semi-permeable membrane between the capillaries and the surrounding material
- Variety of melt processable materials can be used to manufacture the film

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Background

For many years single-bore capillary tubing and hollow fibres have been manufactured from materials such as thermoplastic polymers, by extrusion through a suitably-shaped die. However it has proved extremely difficult to manufacture extruded structures that contain multiple microscopic capillaries, since pressure instabilities within the extruded material cause the capillaries to randomly vary in size, merge or close up.

Technology

Research undertaken at Cambridge University Department of Chemical Engineering has developed a manufacturing process whereby multiple microscopic capillaries can be embedded into polymer tapes and films.

Polymer films have been produced with up to 19 hollow capillaries running continuously along the length of the film, with diameters ranging from 5 to 500 microns. The processing conditions can be altered to control both the diameter and the cross-sectional shape of the micro-capillaries, such that the product can have circular, elliptical or diamond-shaped micro-capillaries, as shown in Figure 1.

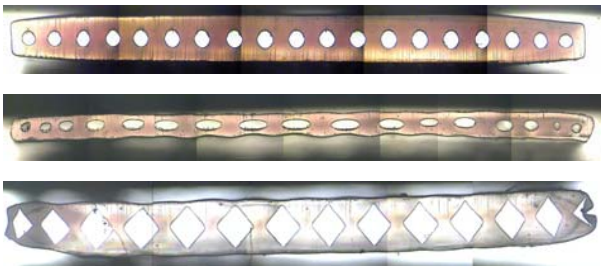

Figure 1: Optical micrographs of micro-capillary films having circular, elliptical and diamond-shaped air-filled capillaries

The micro-capillary films can be produced with either gas-filled or liquid-filled capillaries. It has also been demonstrated that the capillary walls can be chemically treated to obtain catalytic activity, and that the material surrounding the capillaries can be made microporous, creating a semi-permeable membrane.

A number of application areas have been identified for micro-capillary films, as shown in Table 1. It is expected that films could be manufactured from any extrudable material, with up to a hundred embedded micro-capillaries.

Table 1: Investigated examples of application areas

Chemical and biochemical analysis

- Micro-reactor applications
- Microfluidics and fluid transport
- Liquid encapsulation
- Two-phase flow separation
- Chromatography columns
- Capillary electrophoresis (DNA analysis)

Medical applications

- Fluid transport
- Membrane applications

Heat exchange applications

- Cheap, compact heat exchangers
- Solar heat recovery

Pressure sensing applications

Commercialisation

We are seeking partners to work with us to develop and commercialise this research which is protected by regional patent applications in Europe and the US.

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