Microfluidics and bio Polymer microcomponents

Polymers are expected to be increasingly used through the development of microfluidics for bio applications.

The polymer microcomponents industry

Polymer microtechnologies have emerged in the 90s as a low cost alternative technology to Si and glass micro-machining. The launching of the Steag microParts company in 1990 with the FZK Research Center and Pharmacia Biosensor patents, have launched these materials in the MEMS world. At the beginning of 2000, more than 50 companies – mainly capital equipment manufacturers and open foundries – were involved in the polymer microcomponents industry. Most of these companies were based in Europe (figure 1).

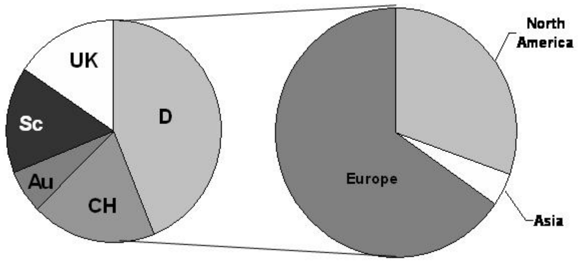

Figure 1: Geographical breakdown of companies involved in polymer micro technologies - capital equipment manufacturers and open foundries (49 companies)

Today, most polymer microfluidics components and services are commercialized by American companies (Tecan, Micronics…). In Europe, Steag MicroParts is the current leader. The polymer microcomponents manufacturing industry is mainly organized into 4 activities:
- Equipment and materials manufacturers (EVG in Austria, Leister Process in Switzerland, Dr Boy in Germany … for equipments. Microchem in US for materials)
- Mold suppliers (Mimotec, Elmicron in Switzerland, Tecan in UK …)
- Open foundries (Steag in Germany, Amic in Sweden, Micralyne in Canada…)
- Integrated foundries (Greiner in Germany …)

Polymer for the MEMS market

Today, polymer represents about 12% of micromachined materials for MEMS manufacturing in more than 360 MEMS companies in the world. Open foundries like Micralyne, who was first working only with silicon and glass, started business in polymer microcomponents especially to fulfill clients' requirements and to respond to cost pressure on microfluidic chips.

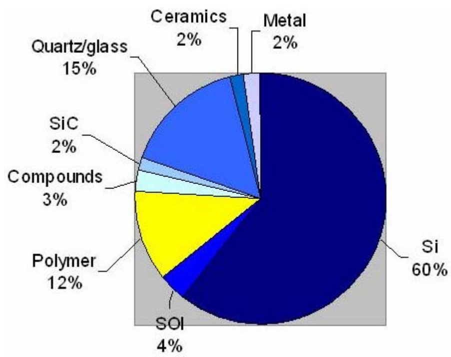

Figure 2: Breakdown of micromachined materials for MEMS fabrication (366 MEMS companies)

Polymer manufacturing technologies

A broad range of technologies is now available for polymer microcomponent fabrication through either direct polymer micromachining or through replication, as shown in figure 3.

Academic institutes and open foundries provide these technologies. Most of the players have developed their core competencies in specific polymer microtechnologies like Microtec a German company specialized in microstereolithography, Diagnoswiss (CH) in plasma etching, Steag Microparts in hot embossing and microinjection etc…

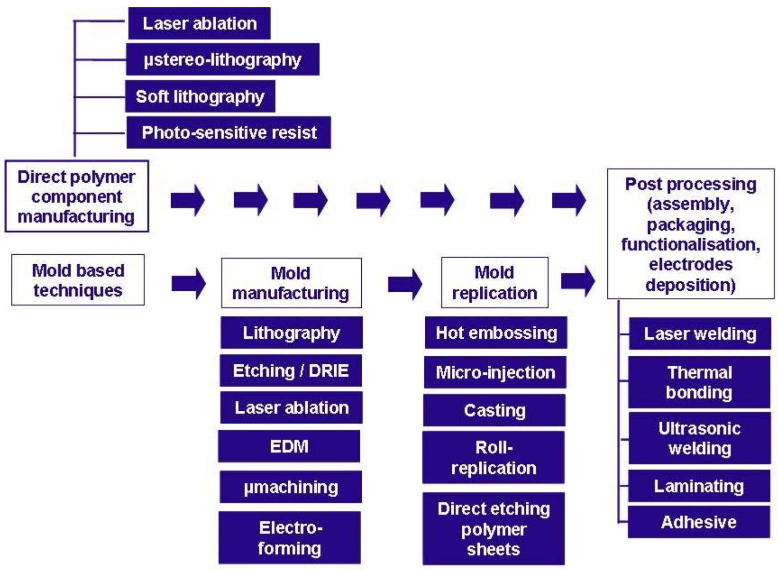

Figure 3: Example of polymer microtechnologies

However the main techniques used remain hot embossing and microinjection. It should be noticed that connections with academic institutes often give companies access to a broad range of technologies.

Moreover it is important to notice that the bottleneck in the manufacturing process is not in the replication of microstructures but rather in the post-processing steps. Gluing polymer parts together, hole-drilling or closing of the microfluidics structures are examples of crucial post processing steps that polymer microcomponents manufacturers are dealing with and which is an important factor in the choice of polymer.

Bringing technological added value to the components

The commercial success of polymer microfluidics components involves not only a reliable technological platform but also easy integration of these components in commercial systems. To this end, polymer microcomponent suppliers improve the technological added-value of their components through:
- Surface functionalization
Companies like AMIC (SE) and SMB (DK) provide functionalized tailor-made surfaces which were limited with polymer compared to glass. However surface chemistry well established for materials like PMMA is still at the development stage for emerging polymers such as SU-8.
- Microfluidics connection
The lack of peripheral equipment and interfaces with the macroworld for microfluidics devices is a main hurdle in the use of micromachined polymer components.
- Providing systems or modules
Another alternative to facilitate the integration of polymer components is to provide directly ready to plug modules or systems. For example, Steag Microparts has developed a nebulizer Respimat® based on microstructured nozzle-, channel-, filter- and pump systems for Boehringer Ingelheim Pharma KG.

Polymer microcomponent applications in Life Sciences

Polymer microstructuring techniques have applications mainly in microfluidics components dedicated to the Life Sciences fields:
- to provide automation of the analysis
- to decrease reagent and sample of volumes used
- to provide very accurate flow dispensing
- to decrease reaction time
- to provide a controlled environment
- to provide protocol step integration in a portable device.

Commercial success is still relatively small and microfluidics technologies are still emerging. The main representative product is the Lab Chip developed by Caliper, an electrophoresis chip in glass. Microfluidics technology is currently predominantly used in pharma and academic research. However through the development of diagnostic POC applications, polymer is becoming a material of choice that can meet the low cost pressure of this market. In 2007, Yole DÈveloppement estimates that polymer microcomponents could reach 1.5 B. Today, the industry of polymer microcomponents is emerging. Materials and technologies are still at the R&D level with few large volume products. However, if manufacturing technologies evolve to allow very low cost component manufacture then polymer microcomponents will become highly competitive. This step will go through standardization and key material/technology for each application. It is also probable that the use of CD and DVD manufacturing technologies for the realization of polymer microcomponents will be a major trend in the near future (it is already done by AMIC in Sweden). Moreover, hybrid technology could also be of great potential when high function integration is required in the component. Such solutions could be provided by companies offering all three technologies –silicon, glass, polymer– such as Micralyne.
Consequently the players in the polymer microcomponent industry have to choose the most successful business models to promote the advantages of polymers for microfluidic devices. They have also to combine the different specific know-how for systems development. The future of polymer microfluidics is largely dependent on the interest expressed by Life Sciences companies who will provide access to the market. A main requirement from Life Sciences systems integrators is to be supplied with feasible, proven prototypes. Then they will enter into close collaboration with the technology provider for the development of the devices. Moreover, the potential of polymer microfluidics will be high when proof of feasibility and adaptability to manufacture will be shown. Then the big step into the Life Sciences market will occur through collaboration with systems integrators and end users.
Yole Developpement has just released the Emerging Markets for Microfluidics Applications “EMMA” report (See p22 for details). If you are interested in, please contact David JOURDAN at jourdan@yole.fr

Emerging Markets for Microfluidics Applications, from R&D tools to mainstream diagnostic products

EMMA 2004 report

Price: Euros 3,500/USD 4,300.
Availability: September 2004.

Yole Developpement has edited a new report ("EMMA") describing the access conditions scenarii of microfluidics technologies in the Life Sciences market. Life Sciences industrial companies are ready to use microfluidics technologies. However further developments have still to be undertaken to reach Life Sciences companies' expectations. In this context, Yole Developpement is proposing a detailed analysis of the most pertinent microfluidic technologies for the different Life Sciences applications, including a detailed analysis of the polymer manufacturing technologies. The report provides an exhaustive analysis of microfluidic technologies, applications and markets as well as an in-depth analysis of emerging applications.
Microfluidics value chain and suitable profitable business model leading to successful developments are analysed. This report presents also the current structure of the microfluidics industry with a description of the major players involved.
Some key analysis of the Yole report will be:
- An analysis of this technological breakdown per application (figure 2).
- The presentation of the possible industrialisation process for microfluidic technologies
- A detailed description of polymer micro components fabrication techniques (figure 3).
- An analysis of the different microfluidics applications with a market estimates 2003 – 2008.
- The organisation of the microfluidics industry
- …
In addition, the report is analysing in details:
- The microfluidics value chain
- The strategy of the different manufacturers
so as to highlight what could be the different profitable business models and scenarii for the future.
Company profiles included in the report:
Aclara, Amic, Bartels Mikrotechnik, Caliper, Diagnoswiss, Digital Bio, Epigem, Fluidigm, Greiner Bio-One, Gyros, Micralyne, Microfluidic Chip Shop, Micronics, Micronits, SMC (Inverness), Steag MicroParts, Weidmann

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