The manufacturing of microfluidic devices harnesses the capabilities arising from multi-disciplinary fields such as chemistry, physics, engineering, microtechnology, and biotechnology. These devices consist of sub-micrometre and sub-millimetre sized channels that can be used to control the movements of miniscule amounts of fluids, the dimensions of which can be in the nano, and even picolitre, scales. The applications of microfluidic devices are increasingly diverse, ranging from ink-jet printing to lab-on-chip and are widely used in biomedical research and diagnostics, chemical processing, water monitoring/processing, and alternative energy exploitation.

By harnessing SIMTech’s multi-disciplinary portfolio of forming, machining, and joining technology along with surface engineering, mechatronics, and precision measurements, the MMP offers a one-stop solution for microfluidic devices development: from design to manufacturing and develop manufacturing technologies for microfluidic applications.

**Mission**
To develop, test, and implement polymer manufacturing technologies for microfluidic applications to nurture and grow the microfluidics industry.

**Core Competencies**

**SIMTech Microfluidics Foundry: Solution provider for microfluidics manufacturing**

- Designing, prototyping, and production services for microfluidic devices
- Supply of polymer-based microfluidic devices to the industries and research community
- Offers standard microfluidic chips and chip-to-world connection kits for industrial and research applications
Projects

• **Microfluidic Mixer for Diverse Applications**
  To meet the mixing requirements in lab-on-chip applications, a design library has been created for documenting the diverse range of passive-mixing components, including the basic Y-mixer, Dean Effect mixer, and chaotic mixer among others. Tackling the challenge of mixing liquids with substantial differences in viscosities, an innovative mixing technique was developed that makes use of a 3D structure to produce the viscous flow instability required to dramatically enhance the mixing efficiency.

  An oscillating mixer, based on a hydro-elasticity mechanism, was also invented, which could convert an otherwise steady laminar flow into high-frequency oscillatory flow at the microscales, thereby achieving instant mixing within milliseconds. These microfluidic mixers have demonstrated applications in biochemical analyses, microreactors, and chemical syntheses.

• **Microfluidics for Multiple DNA Extraction**
  An automatic DNA separation and extraction system was developed to extract multiple DNA fragments on a disposable microfluidic chip in a short time (< 20 min) in comparison with the conventional technique (about 3 hours), with efficiency similar to commercial DNA extraction products. The developed extraction chip realises sample loading, sample stacking by isotachophoresis, DNA separation by gel electrophoresis and target DNA fragments extraction on a disposable polymer chip.

• **Automatic Protein Profiling System**
  A microfluidics based system was developed for performing protein profiling automatically. A disposable polymer microfluidic device associated with the system was developed for gel electrophoresis of proteins, with pre-loaded gel in the device. The operation and detection is controlled by software automatically to perform the whole analysis procedures.

• **Droplet Generator for the Production of Polymer Microbeads for Bioencapsulation**
  A microfluidic-based droplet generation system has been developed for the production of polymer microbeads a few hundred micrometres in diameter. Polymer microbeads, or alginate microbeads, can be generated at high throughput (> 1000 beads/second) with a uniform sized distribution (diameter variation < 3%). Disposable polymer microfluidic chips with innovative features are used in the droplet generation system, thereby avoiding the tedious cleaning process normally required after every operation. The system is enclosed in a chamber to ensure a sterilised environment during bioencapsulation. It has been tested for the generation of beads for many types of polymers and can be used extensively in drug screening, tissue engineering, and pharmaceutical compounding.

Target Industries

• Biomedical research
• Medical diagnostics
• Chemical processing
• Environmental monitoring

Major Facilities

• Polymer Microfabrication and Production Equipment
• Measurement and Testing Tools
• CAD/CAE Software Packages

Technologies Available for Transfer

• Chaotic mixer
• DNA auto extraction system
• Protein profiling system
• Droplet generator
• Micro-oscillator
• Modular syringe system
• Test station

Industry Partners

• Camtech
• CellSievo
• Clearbridge Biomedics
• Fluigen
• JN Medsys
• Molbot
• QuantuMDx
• Solvay Group Rhodia Asia Pacific
• Star Array

Research Partners

• Cambridge University (UK)
• Centre Suisse d’Electronique et de Microtechnique (CSEM)
• Data Storage Institute (DSI)
• Genome Institute of Singapore (GIS)
• Institute of Medical Biology (IMB)
• Institute of High Performance Computing (IHPC)
• Institute of Materials Research and Engineering (IMRE)
• Institute of Microelectronics (IME)
• Institute of Molecular and Cell Biology (IMCB)
• Nanyang Technological University (NTU)
• National University of Singapore (NUS)
• University of Illinois (USA)
• University of Cornell (USA)