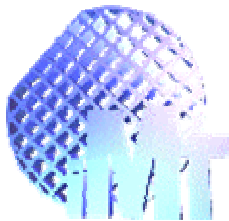


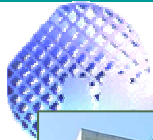
**Droplet-Based Micro-Electronic Fluidic Operations for Production  
and Evaluation Platform BioMEMS**

**BioDrop**

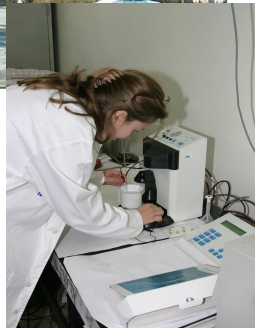


**IMT-Bucharest**





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**Droplet-Based Micro-Electronic Fluidic Operations for Production and Evaluation Platform BioMEMS**

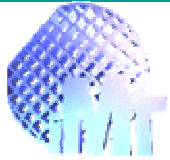
**BioDrop**

**National Institute for R&D in Microtechnologies  
(IMT-Bucharest)**

**IMT-Bucharest**, ([www.imt.ro](http://www.imt.ro)) is coordinated by the **Romanian Ministry of Education and Research** and is the first institute with this profile in **Eastern Europe** (1993) and the main actor in **micro** and **nanotechnologies** in **Romania**

**Mission:**

- ▶ **Scientific research** and **technological development** in **micro and nanotechnologies**, developing a technological pole, integrating R&D with education and training, support for industry (services, technology transfer)
- ▶ **Education and training**
- ▶ **Networking at national and international level** (interaction with European technological platforms)
- ▶ **Technological transfer**



**IMT-Bucharest**



**Droplet-Based Micro-Electronic Fluidic Operations for Production and  
Evaluation Platform BioMEMS**

## **BioDrop**

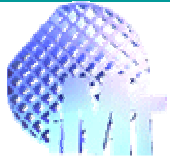
**According to its strategy, IMT-Bucharest is:**

- developing **multidisciplinary research, devoted to the integration of micro-nanobiotechnologies**
- consolidating its role as a technological pole in the micro-nanotechnologies domain
- providing a direct and efficient interaction with companies in order to play a role in technology transfer at the national and regional level

Note: the offer for knowledge and technology transfer in MNT is provided within **a network of suppliers and users (including many public research laboratories and companies)**

The investments in the **MINATECH-RO Scientific and Technological Park for micro-and nanotechnologies** provided the construction of a new “**clean room**”, installing of new equipments and providing room for resident companies (incubation).

**The Centre for technology transfer (CTT-Baneasa)** organized a network of suppliers and users of knowledge and technologies in the domain.

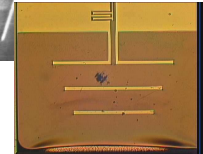
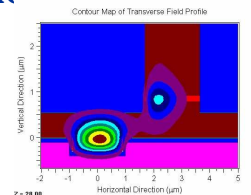


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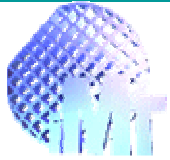
## Droplet-Based Micro-Electronic Fluidic Operations for Production and Evaluation Platform BioMEMS

### BioDrop



## IMT Research Laboratories

- L1. Laboratory of Nanotechnology – research activities and results in **silicon nanoelectrode arrays, porous silicon layers used in drug delivery systems, chips for DNA analysis.**
- L2. Laboratory for Microsystems in biomedical and environmental applications – research activity focused on the development of **microsensors** (chemoresistive and resonant gas sensors), **electrodes for biological sensors, microprobes** for recording of **electrical activity of cells and tissues.**
- L3. Laboratory for Micro- and Nano-Photonics –research, education and training activity in the field of **micro/nano-photonics and optical MEMS** (design, modeling and manufacturing, development of new design tools, new mixed technologies and advanced materials).
- L4.Laboratory of Microsystems and Micromachined Microwave Components –research activity focused on the development of **microwave devices, circuits and RF MEMS** based on silicon and GaAs micromachining ; design, modeling and manufacturing of micromachined **millimeter and sub millimeter wave receiver modules** based on silicon as well as on GaAs technology.



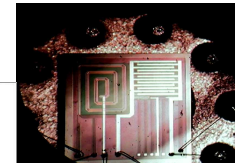
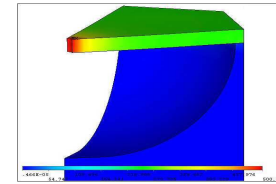
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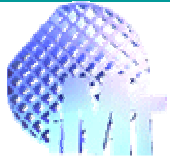
Droplet-Based Micro-Electronic Fluidic Operations for Production and  
Evaluation Platform BioMEMS

BioDrop

IMT Research Laboratories



- L5. Simulation, Modeling and Computer Aided Design Laboratory –research, education and training activities in *simulation, modeling and CAD* for micro - nano structures and materials, microsystems, **microfluidics**
- L6. Microphysical Characterization Laboratory is performing **micro- and nanoscale characterization** of materials and processes to explore manufacturing processes – structure and structure-function (properties) relationships.
- L7. Reliability Laboratory is providing **tools to improve the technology and design of sensors**, actuators and microsystems, by the establishment and improvement of quality and reliability in a Concurrent Engineering approach.



**IMT-Bucharest**



**Droplet-Based Micro-Electronic Fluidic Operations for Production and  
Evaluation Platform BioMEMS**

## **BioDrop**

### **Services offered by IMT include:**

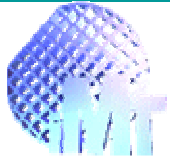
- **Simulation** and CAD for microstructures and microsystems (COVENTOR 2005, ANSYS, Opti-FDTD, Fidelity, IE3D from Zeeland), CAD IC
- **Technological services** (clean room class 100, mask fabrication, wafer processing, silicon and non-silicon processes)
- **Characterization of materials** (AFM, SEM, Elipsometry)
- **Nanolithography** - in the near future

### **Organizing international scientific conferences:**

- **CAS - International Semiconductor Conference**, an **IEEE** annual event- 28<sup>th</sup> edition in 2006
- **“Micromechanics Europe 2002”** (Sinaia, Romania, October 2002)
- **The 1st NanoForum (CMP-Cientifica et al.. Sinaia, Romania, 5-7 October 2003) etc.**

### **Publishing activities:**

- **“Romanian Journal for Information Science and Technology”** (of the Romanian Academy)
- a series of books in **“Micro- and nanoengineering”** (in English, at the Publishing House of the Romanian Academy)
- **“Micro and Nanotechnologies Bulletin”**- quarterly, since 2000.



**IMT-Bucharest**



## **Droplet-Based Micro-Electronic Fluidic Operations for Production and Evaluation Platform BioMEMS**

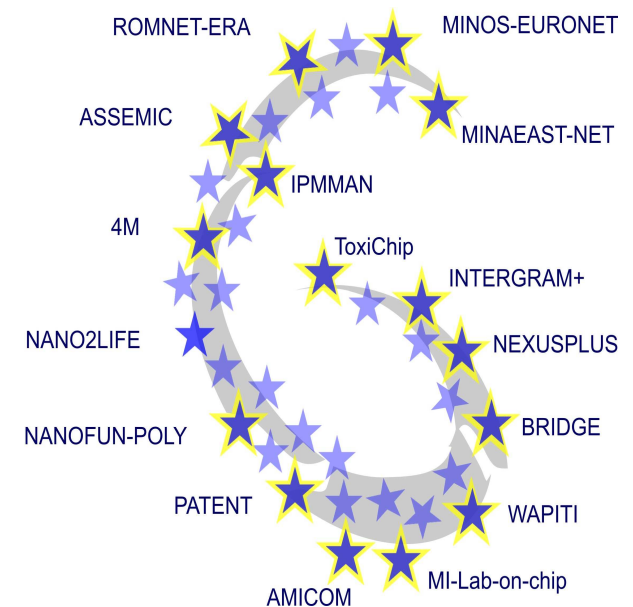
### **BioDrop**

**IMT Bucharest** is involved in the following **FP 6 Projects**:

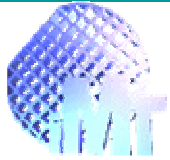
- ▶ **ROManian Inventory and NETworking for Integration in ERA** coordinated by IMT- **ROMNET-ERA**
- ▶ **Micro and NANotechnologies going to EASTern Europe through NETworking Secific Support Action**, coordinated by IMT
- ▶ **Advanced MEMS for RF and Millimeter Wave Communications**, coordinated by LAAS-CNRS Toulouse
- ▶ **Advanced Handling and Assembly in Microtechnology**, coordinated by ISAS-TU Wien- **ASSEMIC**
- ▶ **Design for Micro & Nano Manufacture - PATENT**, University of Lancaster
- ▶ **Nanostructured and Multi-Functional Polymer-Based Materials and Nanocomposites**, coordinated by the Italian Consortium for Science and Technology of Materials
- ▶ **Multi-Material Micro Manufacture: Technologies and Applications**, coordinated by Cardiff University- **4M**
- ▶ **NANO2LIFE** ( IMT associated partener)
- ▶ **WAPITI**, coordinated by Fraunhofer Gesellschaft, München

<http://www.infosoc.ro/>

**A NETWORK TO COOPERATE WITH: MINOS-EURONET-Micro-NanOSystems**  
EUROpean NETwork pursuing the integration of NMS and ACC in ERA



- **INTEGRAM+** (Integrated Project)
- **MI Lab-on-Chip** (STREP)
- **TOXICHIP** (STREP)



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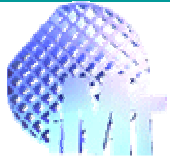
**Droplet-Based Micro-Electronic Fluidic Operations for Production and  
Evaluation Platform BioMEMS**

**BioDrop**

## **L5: Simulation, Modelling and CAD Laboratory**

**Main areas of expertise:**

- ▶ **CAD (based on FEM, FVM, BEM): mechanical, thermal analysis, electric and coupled field analysis of MEMS and MOEMS**
- ▶ **design development and optimization of MEMS microstructures and microsystems (RF MEMS switches, tunable Fabry-Perot optical filters, electrostatically and piezo-electrically actuated)**
- ▶ **design and simulation of microfluidic components for biomedical applications**



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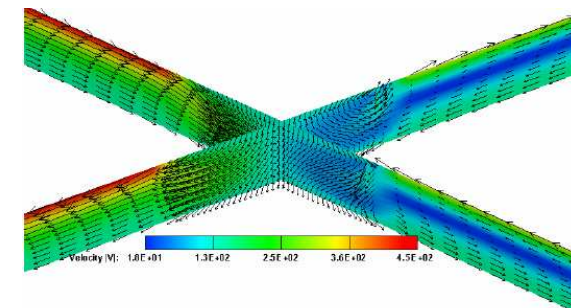
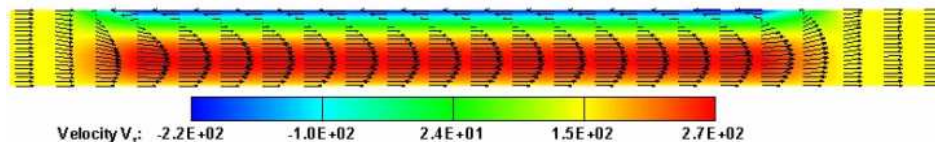
Droplet-Based Micro-Electronic Fluidic Operations for Production and  
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## BioDrop Previous experience in PATENT WP2

- Fault Modelling and System Simulation of Flow-FETs
- Fault Modelling and System Simulation of FlowFET-Based MEF Arrays

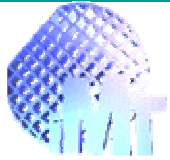
*We cooperate with:*

- MESA+ Institute for Nanotechnology / University of Twente (Testable Design & Testing of Microsystems (TDT) - **Coordinator**)
- CCLRC Daresbury Laboratory Centre for Microfluidics, Centre for Microfluidics and Microsystems Modelling (C3M)



- Simulation using COVENTORWARE 2005

- Webpage: <http://www.nano-link.net/patentF/Project.htm>



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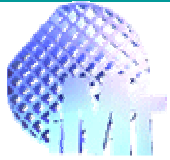
## Droplet simulation using COVENTORWARE 2005

**Design:** 2D Layout + Process Editor → 3D Model  $\xrightarrow{\text{Preprocessor}}$  Discrete 3D Model

**Simulation Module: Bubble-DropSim** Bubble-DropSim provides multi-dimensional (2-D, 3-D, axisymmetric) numerical simulations of two-phase flow with droplet and bubble formation, transport, and impact. It uses the Volume of Fluids (VOF) approach for modeling two-phase flow.

### Analysis:

- Nozzle droplet ejection and exit surface wettability
- Drop formation and mixing
- Droplet transport and impact with solid parts
- Dielectrophoresis and electrowetting on dielectric
- Thermocapillarity

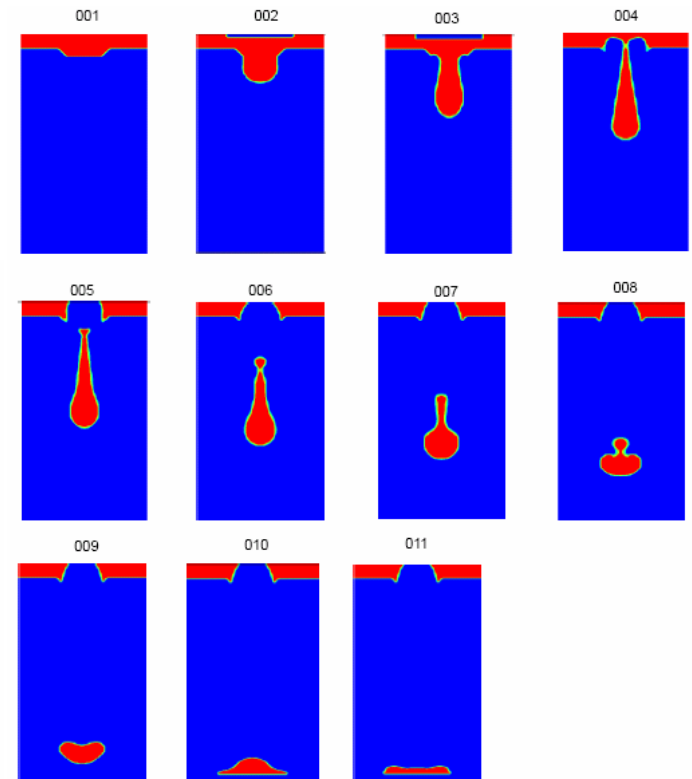
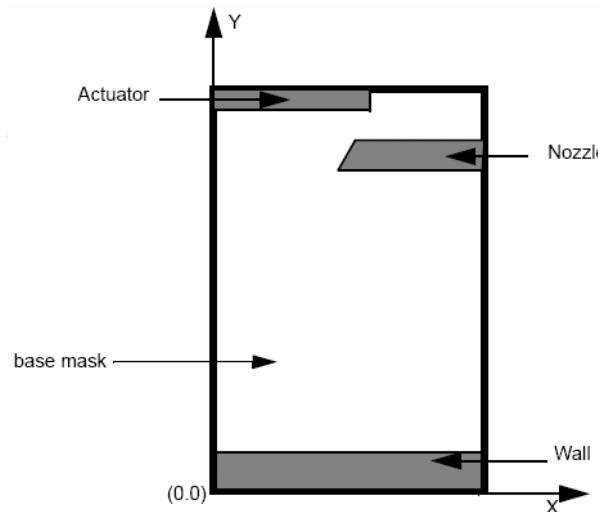


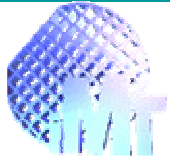
## Droplet simulation with COVENTORWARE 2005

### EXAMPLES

**Drop Formation:** A submerged microheater is used to create a droplet, which then leaves the reservoir through an orifice in the top wall.

Axisymmetric problem:  
A drop is formed at the nozzle, grows, pinches off, and hits a target object after moving through some distance





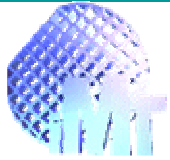
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**Droplet-Based Micro-Electronic Fluidic Operations for Production and  
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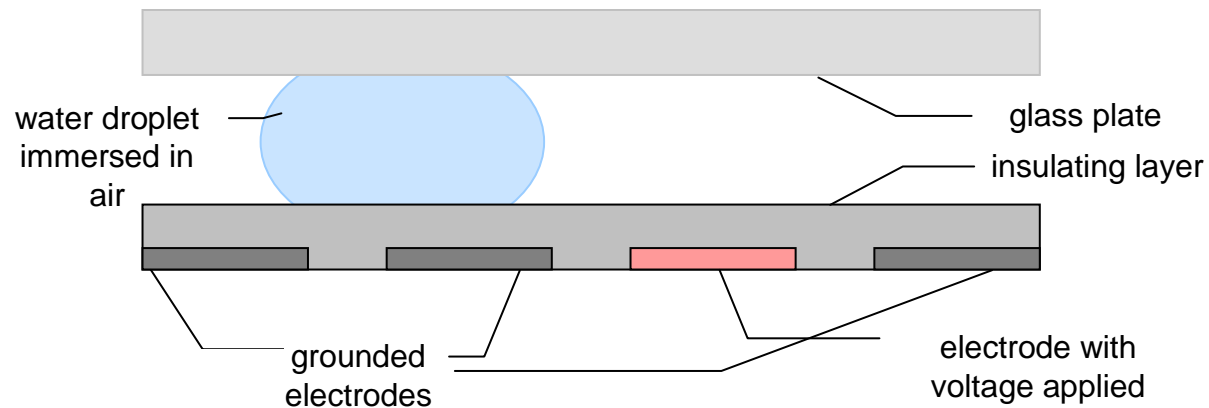
## **BioDrop**

- ▶ **The Bubble-DropSim Module of CoventorWare 2005 permits multi-dimensional numerical simulations of two-phase flow, with droplet and bubble formation, transport and impact.**
- ▶ **Using the Volume of Fluids method for modeling two-phase flow, the module allows the modeling of phenomena such as: digital microfluidics, dielectrophoresis and electrowetting on dielectric, non-contact droplet transfer onto receiving surface, liquid source pin transfer process, behavior as defined by surface wetting/ capillary action.**
- ▶ **CoventorWare 2005 can be used to simulate the translocation of a droplet using an ElectroWetting-On-Dielectric (EWON) device.**

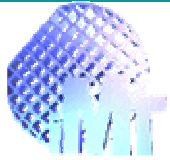


## Previous work related to the subject of the BioDrop Project

- ▶ Below it is presented the layout of the electrowetting devices, simulated with CoventorWare 2005.
- ▶ The device consists in a thin dielectric coating that separates a droplet and an electrode. If an electric field is applied on an electrode, an electrohydrodynamic force appears and it has as result the translocation of the droplet.

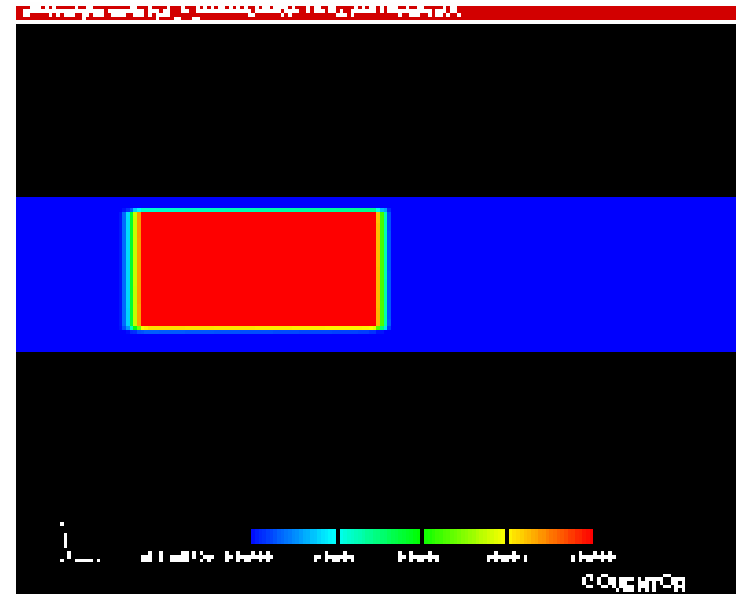


*The layout of the electrowetting device, as it is simulated using CoventorWare 2005*

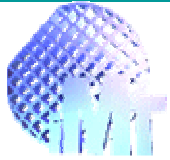


## Previous work related to the subject of the BioDrop Project

- ▶ The results of the simulation clearly show how the water droplet is moved from its initial position, by applying a voltage on a nearby electrode.
- ▶ First it is observed the reduction of the contact angle between the droplet and the surface, than the complete movement of the droplet



*Results of the simulation using  
CoventorWare2005*



**IMT-Bucharest**



**Droplet-Based Micro-Electronic Fluidic Operations for Production and Evaluation Platform BioMEMS - BioDrop**

## IMT Bucharest work plan

**Task 1:** CoventorWare simulations of the design and evaluation of simple test structures, for the study of failure modes and faults of droplet fluidic operations (injection, transport, merging)

**Task 2:** Simulations for the design and evaluation of bio-fluidic droplet structures. focussed on the QinetiQ droplet device. Analysis for optimisations of numerical models. Simulation of the droplet sensing operation could also be possible depending upon the sensing principle.

**Task 3:** Responsibility on design and maintenance of BioDrop website. Contents material to be provided by partners.

## IMT Deliverables:

**IMT-D1:** Joint CCLRC/IMT report on Task 1 - preliminary simulations for the experimental droplet device (Q3 2006)

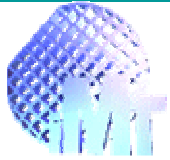
**IMT-D2:** Final report on design simulations of the QinetiQ cell evaluation device (Q2 2007)

**IMT-D3:** Finalized BioDrop Website (Q3 2007)

## IMT Milestones:

**IMT-M1:** Complete numerical study and joint CCLRC/IMT report for the experimental droplet device (Q4 2006)

**IMT-M2:** Complete numerical design study and report for the QinetiQ cell evaluation device (Q2 2007)



**IMT-Bucharest**



**Droplet-Based Micro-Electronic Fluidic Operations for Production and Evaluation Platform BioMEMS - BioDrop**

## **What we need from our partners in order to perform the simulations:**

- ▶ **Details about the design – geometrical parameters**
- ▶ **Details about the technological process used to build the structure**
- ▶ **Material properties for the materials that are used (viscosity, density, dielectric constants)**
- ▶ **Input working parameters: applied electric potential, initial conditions, Interfacial Tension Coefficient, Static Contact Angle, pressure and / or other parameters as function of actuating method**

### **People from IMT-Bucharest involved in the BioDrop project**

- ▶ **Dr. Raluca Muller** (ralucam@imt.ro)
- ▶ **Mat. Oana Nedelcu- PhD St.** (oanan@imt.ro)
- ▶ **Mat. Irina Codreanu- MSc St.** ( irinac@imt.ro)