



## 1. Contextual explanation of research

- **Objective:** create a cheap, flexible and generally accessible system for water monitoring against pollution with non-organic ions.
- **Nine partners** create the SEWING consortium:
  1. Politechnika Warszawska, Warsaw, Poland
  2. Institute of Electron Technology Warsaw, Poland
  3. Technical University of Lodz, Lodz, Poland
  4. Valtion Teknillinen Tutkimuskeskus (VTT), Espoo, Finland
  5. Centre National de la Recherche Scientifique (LAAS –CNRS) Toulouse, France
  6. MICROSENS S.A., Neuchatel, Switzerland
  7. Universitat Polytechnica de Catalunya Barcelona, Spain
  8. Institut fuer Wasserversorge, Gewaesserekologie und Abfallwirtschaft (IWGA) Vienna, Austria
  9. Systea, Rome, Italy
- **Interdisciplinary project:** Electronics, informatics, chemistry, semiconductor technology, environmental engineering.



**The following problems** are to be solved in this project:

1. Choice of the most important areas, where the microsystems will be used.
2. Fabrication of sensors being Ion Selective Field Effect Transistors (CHEMFETs)
3. Computer simulation of sensors compatible with other electronic simulators
4. Creating software and hardware for data processing of information obtained from many sensors
5. Creating software and hardware for information storing, coding and transmission.
6. Assembling all the parts into one smart microsystem
7. Institutions responsible for water management will receive the prototypes of the microsystems to demonstrate their usefulness in a real environment
8. Industrial partners will prepare the prototypes for industrialisation.

The project is now in the middle of three-years duration. The following is the main result obtained so-far.



The key result:

## 1. The Most important part of the system are SENSORS

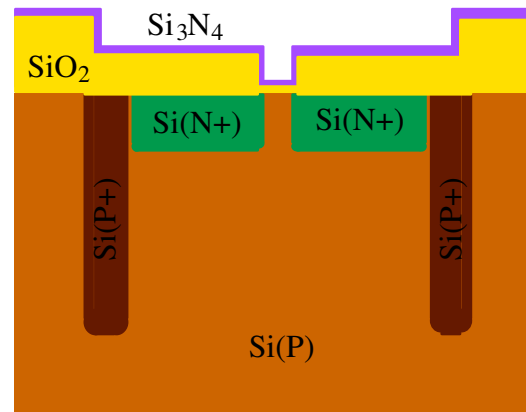
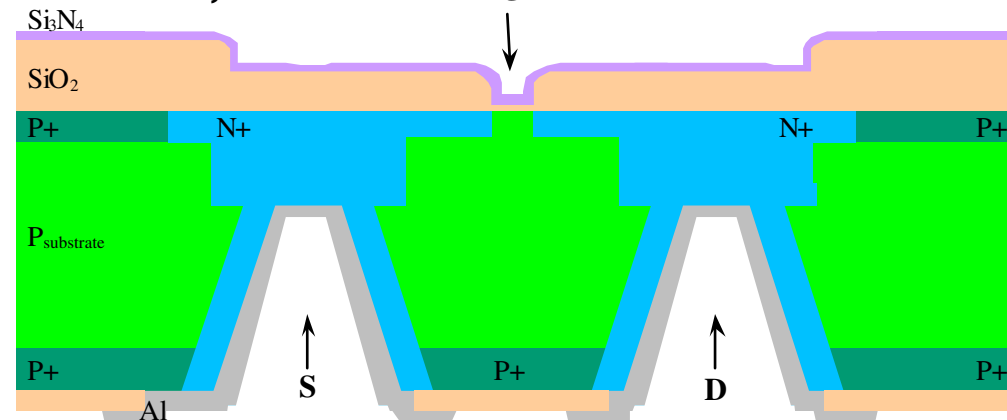
They are realised on the basis of ISFETs, fabricated in Warsaw and in Toulouse

**Back-Side-Contact ISFETs (BSC)** are fabricated in Warsaw.

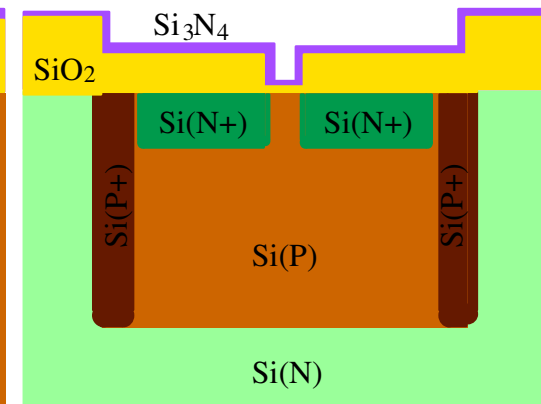
They do not need encapsulation, are easily mounted, technology is more complex.

**Front-Side-Contact ISFETs (FSC)** are fabricated in Toulouse.

They need encapsulation, mounting is more complex, technology simpler

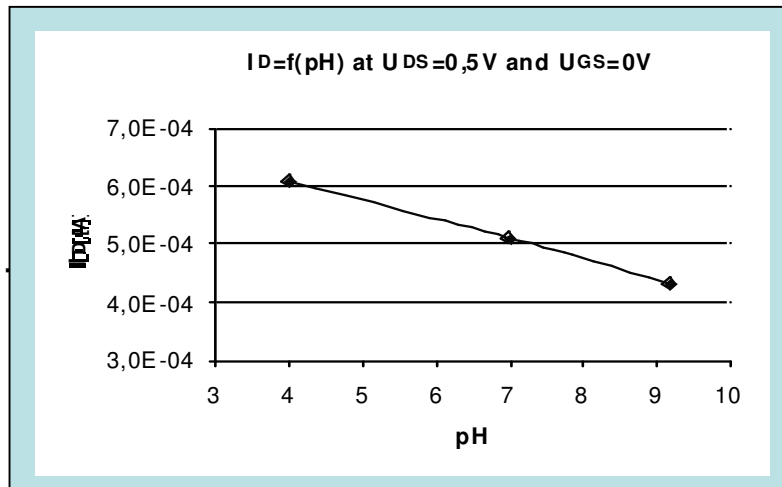


P-substrate FSC

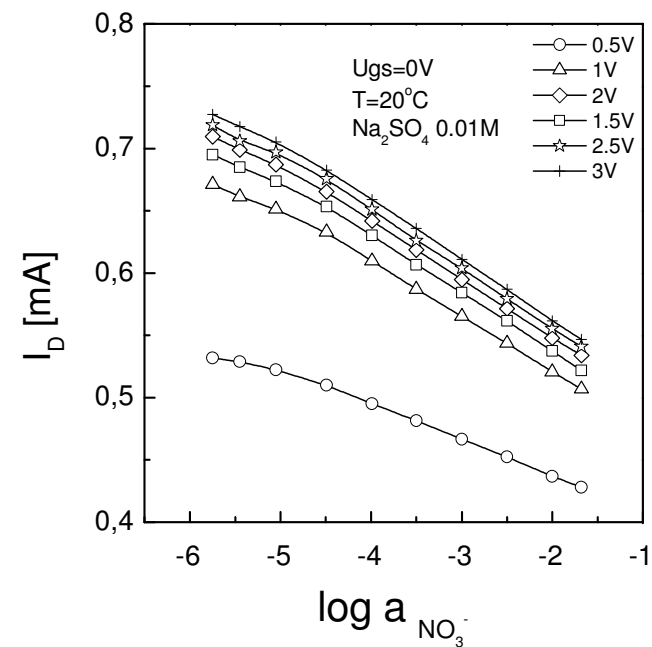


P-Substrate N-well

**2. Measurements of CHEMFETs.** The specialised equipment was mounted  
The results of measurements are shown



The sensitivity and selectivity in respect to interfering ions give the possibility of creating the CHEMFET model



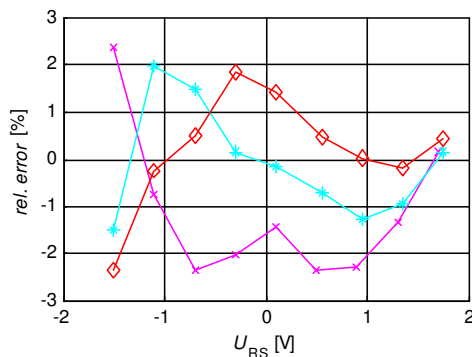
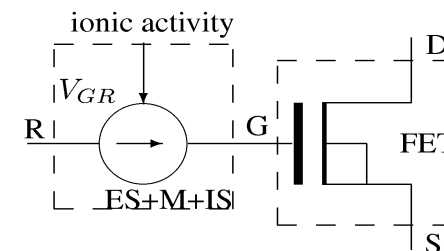
## Exploitation of CHEMFET results

This key result opens the next activities:

- **CHEMFET modelling**

Measurements of CHEMFETs and of their selectivity gave the possibility to create models suitable for different simulators. CHEMFET model composed of the Merckel MOSFET model with Nikolski-Eisenman type membrane model is developed.

**URS** is the reference electrode-source voltage and **VGR** models the transducer activity. There are 7 parameters, which can be extracted from measurements.



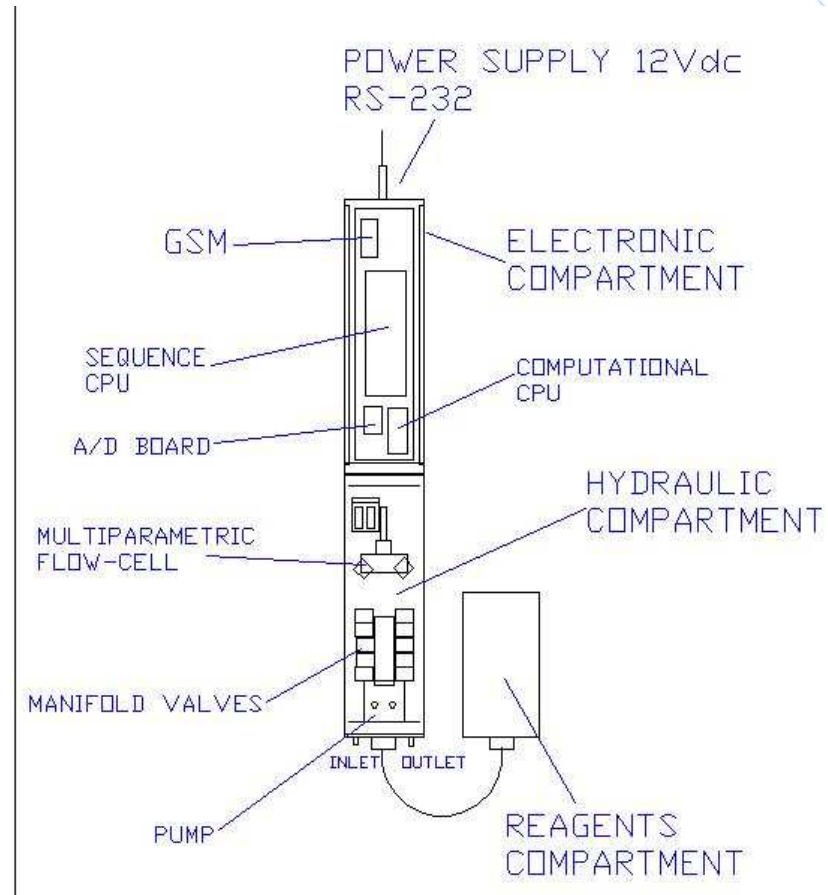
Here are the errors of the model compared with the measurements for different  $U_{DS}$  for concentration of potassium ions equal to  $10^{-6}$  mol/l and concentration of interfering sodium ions =  $0.1$  mol/l.



## SEWING - System for European Water monitorING



- **Probe construction**  
SYSTEAM in Rome, Italy propose the probe containing the smart sensor as in the figure. The electronic compartment has chips with data processing and controlling hardware. In the hydraulic compartment there are the flow-cell with CHEMFETs and valves. The monitored liquid is pumped, measurement done, than washing from the reagents compartment and calibration is performed. The GSM transmitter sends data.



- **Data processing.** Based on CHEMFETs models software is developed for extraction of data concerning the concentration of particular ions. This is coded and stored in RAM. Appropriate hardware realising that is being developed. This will be transmitted by GSM network and visualised in central computer.



### Importance for future RTD

- **Future use of SEWING.** The system SEWING will be used in broad and universal water monitoring by inserting hundreds of smart sensors and collecting data in national or regional offices responsible for sustainable development.
- **NoE in the FP6.** Based on the experience in SEWING a new proposal is being prepared. This is a Network of Excellence **SIMPLE: System for Integrated Monitoring of environment PoLlution in Europe.** The network will enable mutual contacts, exchange of experience, scientists and equipment, giving as an effect unified and integrated system with standard hardware and software in the field of monitoring **Water, Air, Soil, Noise, Radiation and Electromagnetic pollution.**
- **Spin-off projects.** Institutions co-operating with SEWING and SIMPLE will be able to propose new IPs, NoE, STREPs etc in the field of monitoring and diffusion of data concerning environment pollution. This is so important for sustainable development in Europe.



### Further development using IST

- **Sensor development.** Electronics and Chemistry will work further to create new CHEMFETs selective for a broader selection of ions to be monitored. Further progress in accuracy, life-time and sensitivity of CHEMFETs will be done.
- **Data processing development.** Software and hardware for data extraction, fusion and aggregation will be developed. In particular the alarm mode of sensor work, information about their degradation etc are important.
- **Transmission of data.** GSM network is only one of many possibilities of data transmission. Point-to-point communication, blue-tooth, cable, optical etc. are also possible and should be developed.
- **Data visualisation.** It is of particular importance to have visualisation standardised in such a way, that people not skilled in IT can use the system.
- **Extending the experience for other areas.** The system SEWING can be extended to any monitoring field, from environment, through medicine to social sciences and governments.
- **Lowering the costs.** Economic aspects should be taken into consideration.