UNIVERSITÄT DES SAARLANDES

Lehrstuhl für Messtechnik

Sensor systems for environment and health: challenges and opportunities

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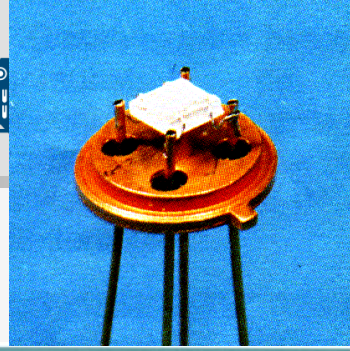
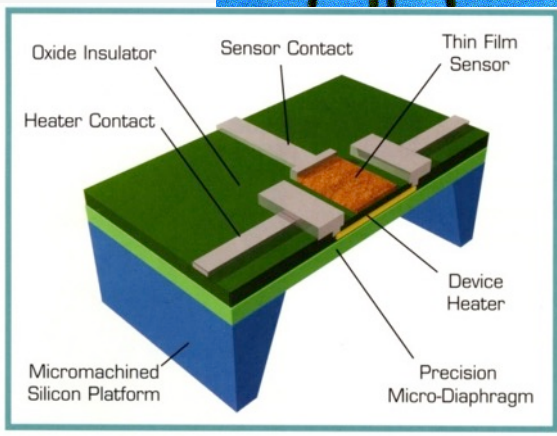
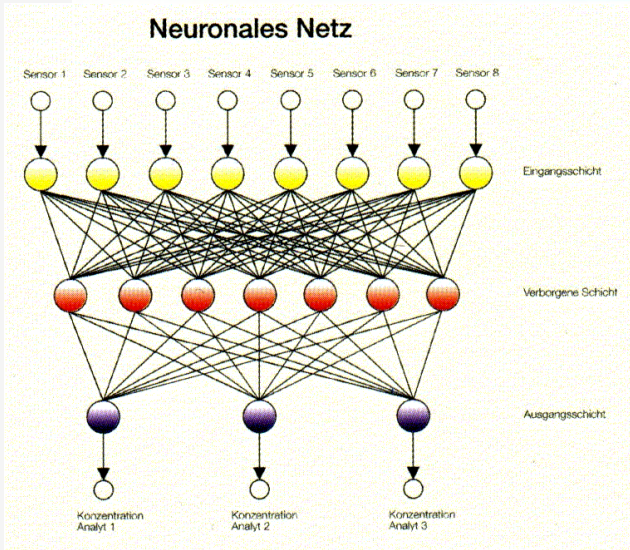
> Research focus: gas measurement systems

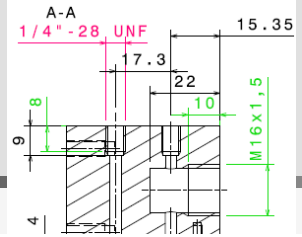


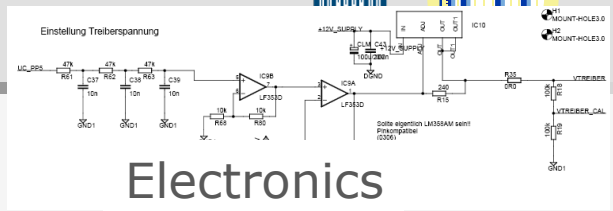
- On-going cooperation with sensor manufacturers for
  - characterization of MOS, GasFET sensors & pellistors
  - improvement of sensitive layers (sensitivity, stability, selectivity)
  - thick film sensors and microsensors (Si, SiC)
- Development of "virtual multisensor systems"
  - dynamic operating modes (i.e. temperature cycling, impedance spec.,...)
  - multisensor signal processing to improve selectivity and stability
- Main application fields: safety and energy
  - early detection of smoldering fires
  - leakage detection of chemicals and gases
  - demand controlled ventilation (IAQ)
- Other application areas include:
  - leak detection of devices and packages
  - evaluation of smell, fuel sensor system, …



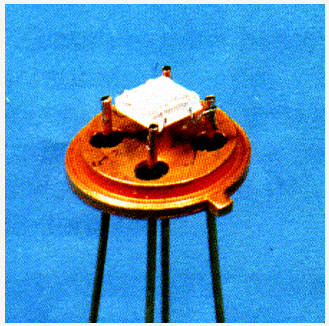


> Overall approach

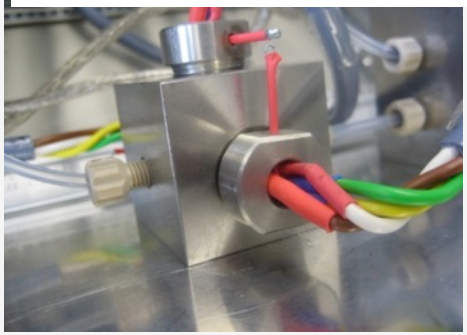




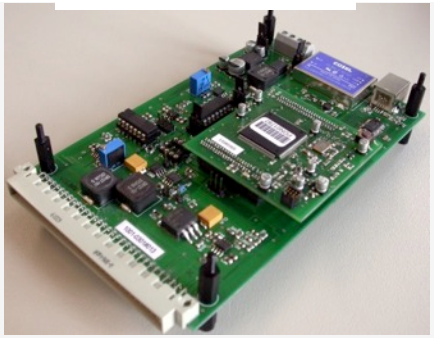
Sensor elements



Mechanical setup

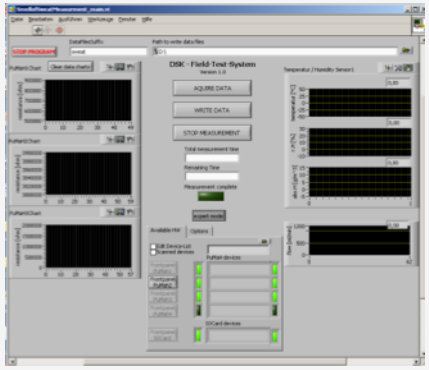


Electronics

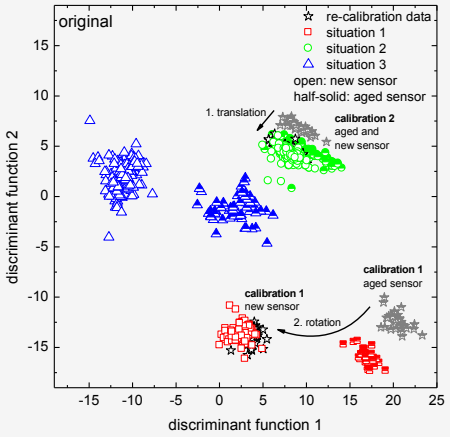


Field testing!

Operating software



Data evaluation



VOC-IDS: Volatile Organic Compound Indoor Discrimination Sensor

- Transnational project funded within MNT-ERA.net
- Selective VOC detection, primarily formaldehyde, benzene
- Novel ceramic nanomaterial MOX semiconductor gas sensors
- Intelligent signal processing based on temperature cycling
- Networked systems connected to KNX bus

SENSIndoor: Nanotechnology based intelligent multi-SENsor System with selective pre-concentration for Indoor air quality control

- EU-FP7 project NMP.2013.1.2-1:
  Nanotechnology-based sensors for environmental monitoring
- Microtechnology based approach for MOS and SiC-GasFET sensors
- PLD deposition of sensing layers
- Pre-concentration (MIPs and MOFs) to boost sensitivity and selectivity
- Integrated multi-sensor approach
- Application specific priorities and field tests

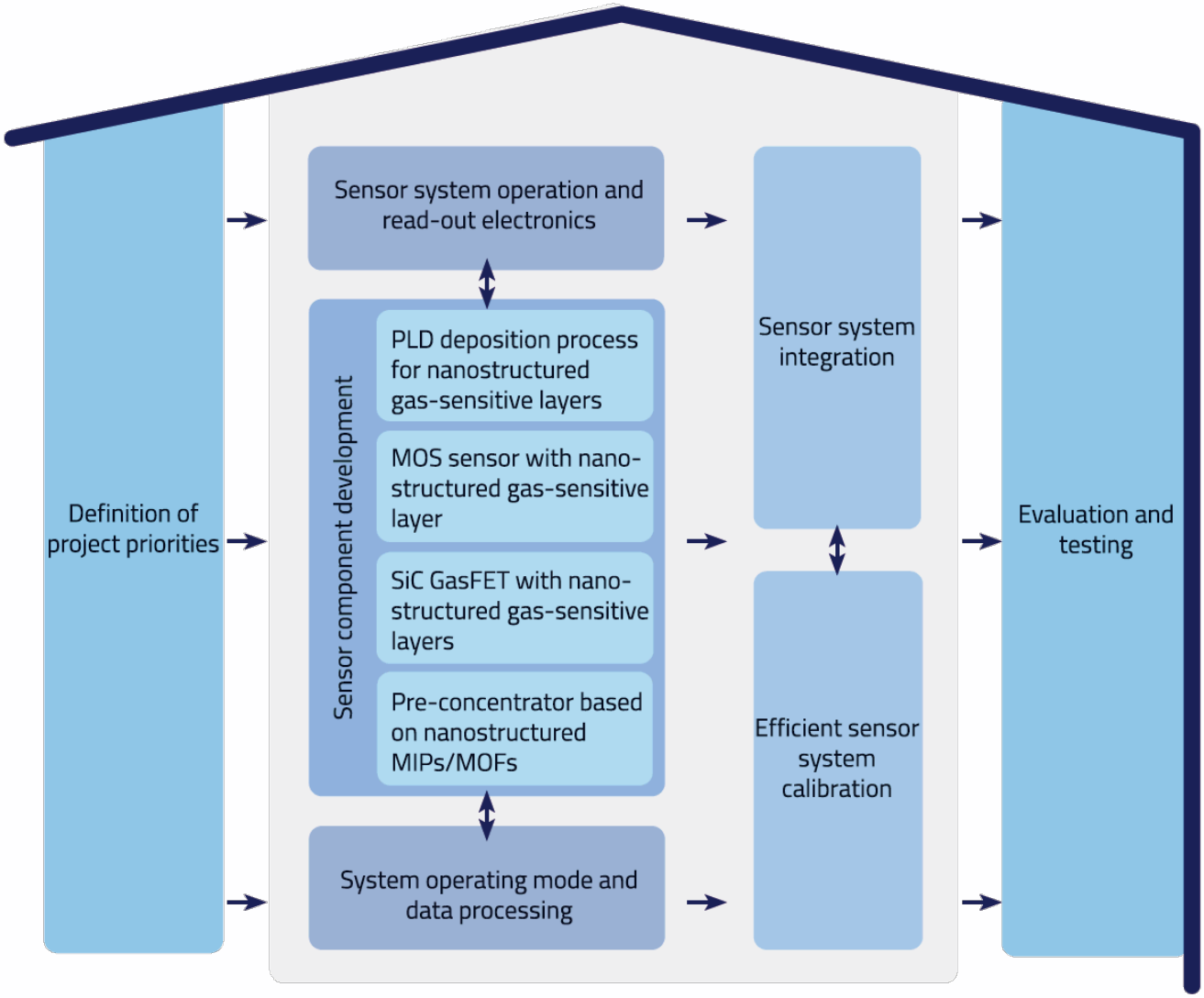
SENSIndoor overview

Project

SENSIndoor

Funded by EU-FP7 grant agreement No 604311

For more information visit www.sensindoor.eu



AMA Verband für Sensorik und Messtechnik e.V.

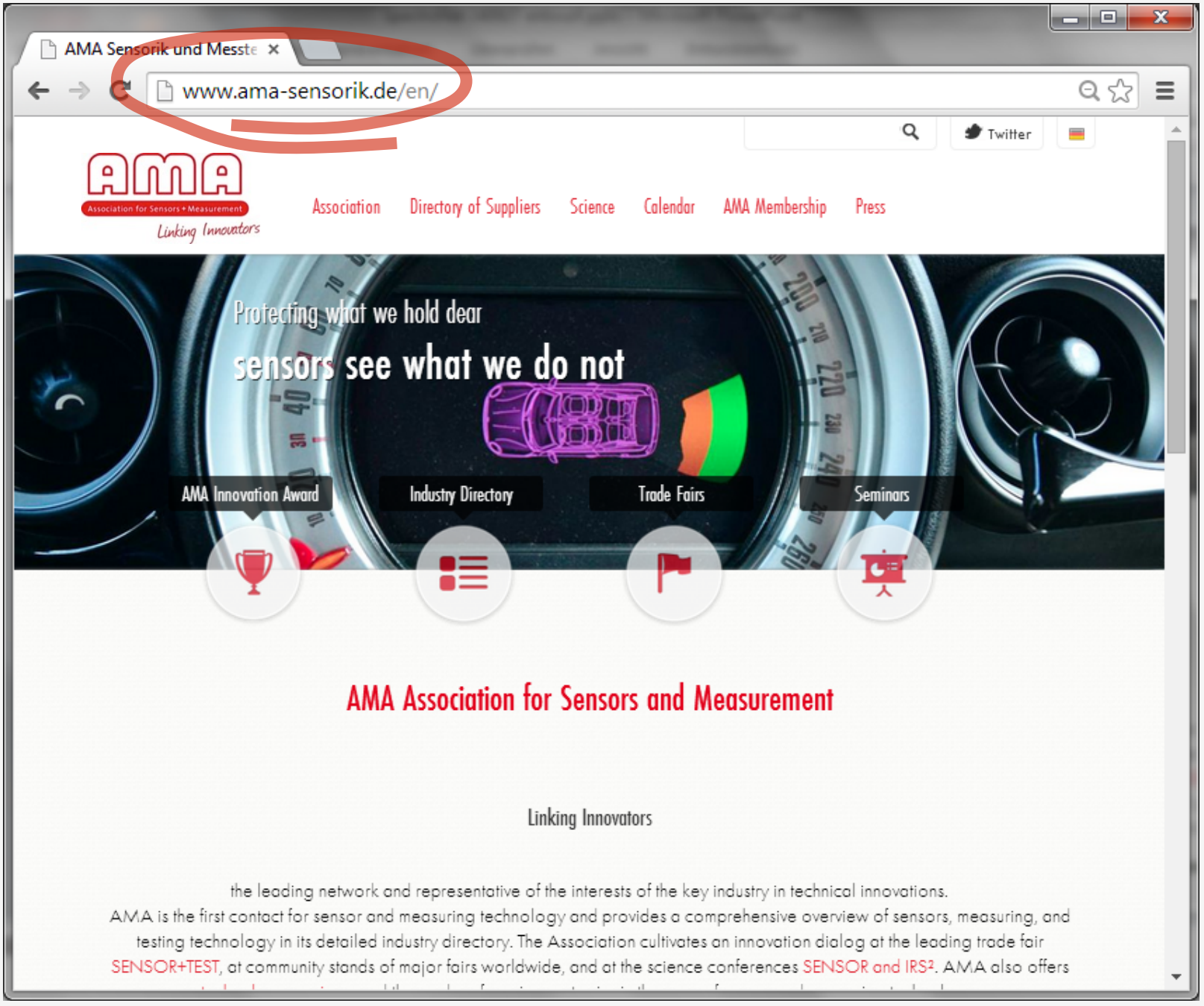
AMA Association for Sensors and Measurement

The Leading Network and Representative of Interests for the Key Sector for Technical Innovation

400 companies

70 research institutes

- Trade fair SENSOR+TEST
- Industry Directory: suppliers for sensors and measurement technology
- Community stands for sensor and measurement technology at diverse trade fairs
- Scientific conferences SENSOR, IRS^2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AMA Association for Sensors and Measurement
Linking Innovators
the leading network and representative of the interests of the key industry in technical innovations.
AMA is the first contact for sensor and measuring technology and provides a comprehensive overview of sensors, measuring, and testing technology in its detailed industry directory. The Association cultivates an innovation dialog at the leading trade fair SENSOR+TEST, at community stands of major fairs worldwide, and at the science conferences SENSOR and IRS².

Sensor systems for environment and health: challenges

- Physical sensors (temperature, pressure, radiation) well established
  - ➢ Notable exception: particle sensors
- **Chemical sensors remain a huge challenge – but why?**
  - **Sensitivity**: huge spectrum from % to ppt (odorants)
  - **Selectivity**: extremely high dimensionality plus matrix effect
    - ➢ For many applications the most critical challenge
  - **Stability**:
    fundamental trade-off between selectivity (= high binding energy) and reversibility (requires low binding energy or high temperature
    - ➢ One possible solution are single-use biosensors (e.g. glucose)
    - ☹ Not suitable for continuous monitoring applications

Sensor systems for environment and health: opportunities

- **Nanotechnology**: application specific material design
  - Sensing layers, but also filters, catalysts etc.
  - ➢ Close interaction with characterization tools
- **Microtechnologies**: low-cost manufacturing and system integration
  - Multisensors, filters, optical particle sensors
  - ➢ Efficient development req. multi-physics models and model validation
- **Active/dynamic operation**:
  - Measurement at low, release at high temperature, switching filters,…
  - ➢ Efficient development req. multi-physics models and model validation
- **Networked sensors and advanced HMI**:
  - Distributed/redundant sensing; feedback for on-site adaptation

Exemplary projects

- **Multifunctional nanomaterials with multiparameter read-out:**
  - Resistance, impedance, mass, optical properties,…
  - More information plus self-monitoring capability
- **Specifically for IAQ**
  - **Networked adaptive environment quality sensors w intuitive user feedback**
    - Multifunctional multisensors (T, r.h., VOC, air speed, radiation, noise,…)
    - Novel human machine interface for comfort, odor,…
    - Indoor and outdoor
  - **Demonstration project for IAQ and energy savings**:
    - Integr. solution with demand controlled ventilation and air treatment
    - Monitoring of health effects (asthma, allergies, acute resp. diseases)
    - Total cost of ownership: trade-off between investment and savings
- **Similar projects for health (breath analysis), food and water quality**:
  - Chemical sensors for liquids lag significantly behind!

Cluster governance: goals and expectations w priorities

Achieve increased awareness of invisible environmental issues

- Public awareness plus policy makers
- Without guidelines and regulations, sensors will not be used

Influence future calls (EU, but also national & ERA.net)

Networking: research, manufacturing, end users

- Chemical sensor systems only successful when adapted to specific applications
- A single sensor element does not solve any problems

For established projects:

Clustering of projects (again EU plus national)

- Exchange ideas, results (sensor elements, data,…) and tools (characterization)
- Link basic research with application oriented projects → faster innovation?

Establish an ITN or RISE Network

Cluster governance: interlinking

- WHO, EPA, EEA: regulations and public awareness
- AMA Association for Sensor and Measurement
- EuNetAir: Indoor and outdoor air quality
- International Society of Indoor Air Quality and Climate (ISIAQ)

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