European Network on New Sensing Technologies for Air Pollution Control and Environmental Sustainability - *EuNetAir*

COST Action TD1105

WGs & MC Meeting at SOFIA (BG), 16-18 December 2015

New Sensing Technologies for Indoor Air Quality Monitoring: Trends and Challenges

Action Start date: 01/07/2012 - Action End date: 30/04/2016 - Year 4: 1 July 2015 - 30 April 2016

Wrap-up of presentations

WG2

UNIVERSITÄT DES SAARLANDES

Lehrstuhl für Messtechnik

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cost EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

EuNetAir

European Network on New Sensing Technologies for Air-Pollution Control and Environmental Sustainability

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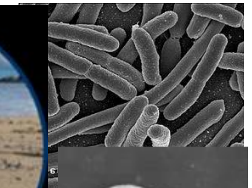
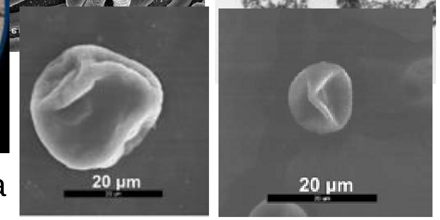
European Science Foundation: ESF provides the COST Office through a European Commission contract

M. Voinova, Chalmers University of Technology, Göteborg, S

Predictive modeling of SAW-based and QCM-D sensors





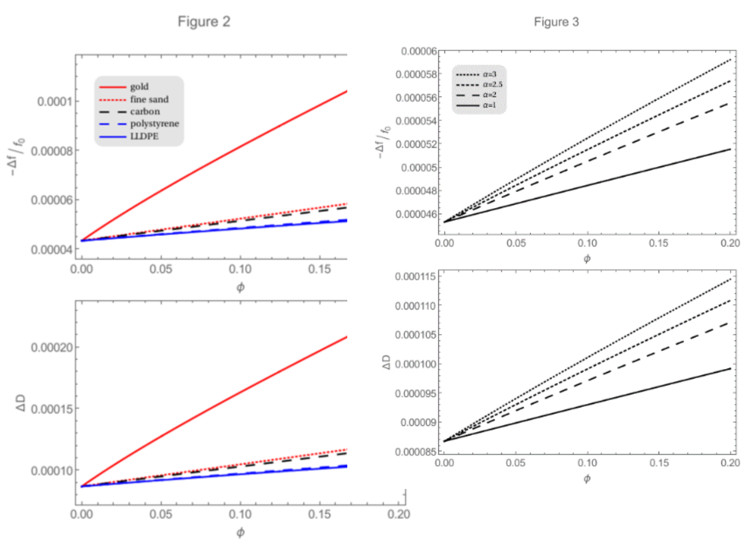
Current research topics / Problem statement

- **Acoustic biosensors for healthcare (modeling)**
- **Acoustic sensors for environmental control (modeling)**
- **Goal1: Air quality control**
- **Goal2: Clean water control (precipitations; coastline sea water)**

Target pollutants :Microparticles and NPs dispersions, aerosols. Mineral,organic and bioorganic dust (bacteria and viruses), Pollen microparticles, microplastic fragments dispersed in water, marine aerosols

Pollutant model NPs

- **Gold NPs**
- **Fine sand grain**
- **Carbon NPs**
- **Polystyrene**
- **PVC**
- **E.Coli bacteria**



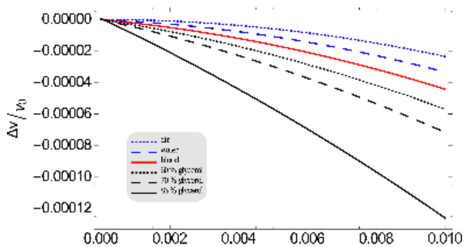
Plots. (to the left) A bare QCM-D, operating at a frequency *f*=1 MHz, in water containing by spherical (shape factor α=2.5) nanoparticles at different (low) concentrations ϕ. The nanoparticles affect the effective viscosity (as given by Einstein's expression) and density of the contaminated water. The plot shows the effect of spherical nanoparticles of different material.
(to the right): A QCM-D coated with a 10 nm PMMA-film, operating at a frequency *f*=1 MHz, in water contaminated by rigid PVC nanoparticles at different (low) concentrations ϕ. The density of rigid PVC is known, and the plot shows different shape factors α (α=2.5 corresponds to spherical nanoparticles).
(Voinova, Wikström, 2015, manuscript in preparation)

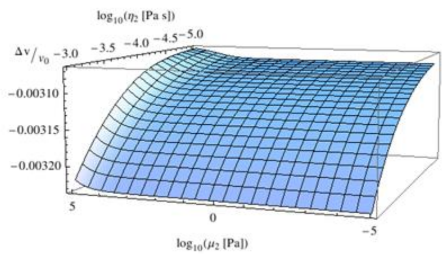
Pictures: plastic litter (MICRO2016 'Fate and Impact of Microplastics in Marine Ecosystems:From the Coastline to the Open Sea); E.coli (wiki);pollen micrographs (Tan,Friend,Yeo. Microparticle collection and concentration via a miniature surface acoustic wave device . Lab-on-a-Chip 7 (2007)); mineral particle and carbon aggregates(Kocbach, Li, Yttri, Cassee, Schrarze, Namork. Physicochemical characterization of combustion particles from vehicle exhaust and residential wood smoke. Particle and Fibre Toxicology 3 (2006)).

Brief list of ongoing research topics

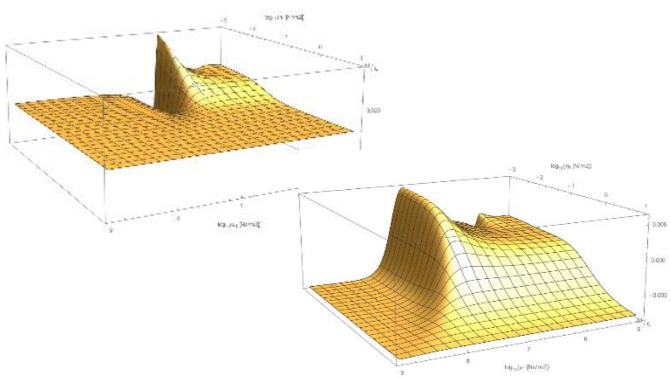
Predictive modeling of SAW-sensors and QCM-D

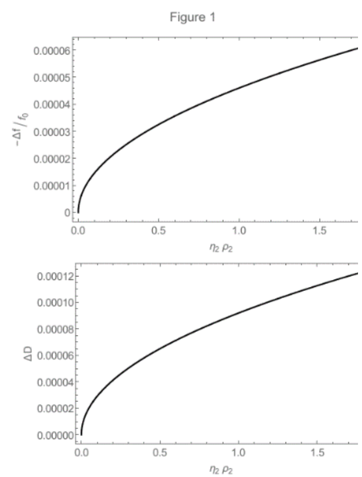
- Analytical formulae and numerical results for the phase velocity change of SAW (SH-SSW) sensor characteristics for (bio)organic (polymer) receptive coatings. Predicted ’missing-mass’’ effects in liquid phase operation. Gravimetrical sensitivity amplification in liquids.

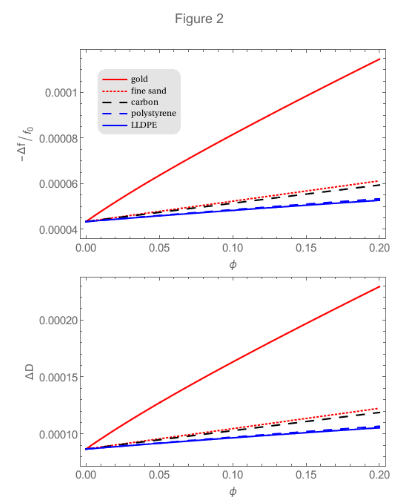




- Analytical and numerical results for the shift in the resonance frequency and dissipation of QCM-D sensors for dispersions of microparticles and NPs in liquids: finding the concentration of particles and the shape factor







(Voinova, Wikström, 2015, manuscript in preparation)

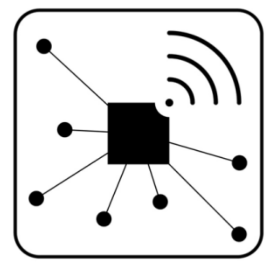
SUMMARY

- Predictive modeling: from the physico-mathematical analysis of the acoustical impedance derived for both SSW and QCM-D sensors we obtain the measurable characteristics ($\Delta v, \Gamma, \Delta f, \Delta D$) as a function of the concentration of pollutant microparticles in water droplets. For non-spherical particles, the correction for the shape factor may be deduced from measurable characteristics

The analytical formulae in parallel with numerical calculations open a way to quantitative interpretation of the experimental measurements of aerosols, colloids, biological colloids to determine the level of pollution (mineral particles, dust, bioorganic dust, NPs).
In the future practical applications, the general analytical expressions derived for the SSW- and QCM-D characteristics may be used as a basis software for the sensors detection of pollutants in the humid air and water microdroplets.

Romy Hoffmann: Siemens AG and TU Freiberg, Germany

- **Background / Problem statement:**
  In the context of the EU-funded ESEE project ("Environmental sensors for energy efficiency", promoted by ENIAC JU Nr. 324284) we want to develop a low-cost gas sensor arrays **(FBAR, 64 transducers)** for energy efficient air quality management. The challenge here is to achieve sufficient sensor stability, resolution and selectivity, especially for CO_2.

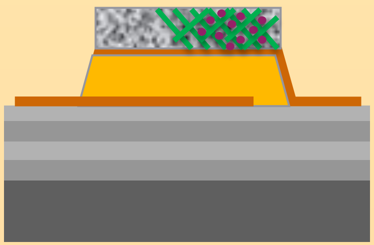


- **Objectives:** New sensing technologies for AQC, Environmental sustainability

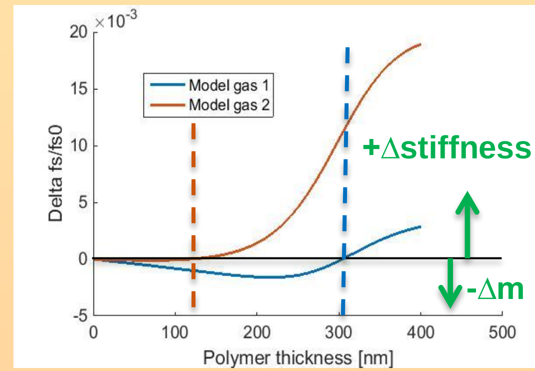
Dual effects, multisensor readout

Summary:

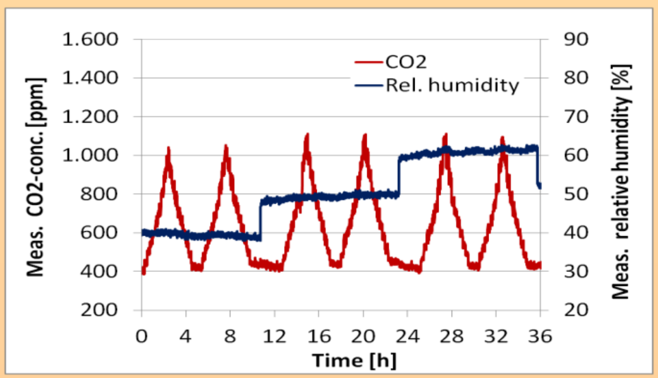
- FBAR has potential to be a low-cost, multi-gas sensor for AQM



- Due to its ability to detect Δmass and Δstiffness



- different polymer compositions, thicknesses and operating temperatures can be used to eliminate cross-sensitivity



- Stability still has to be evaluated

cost
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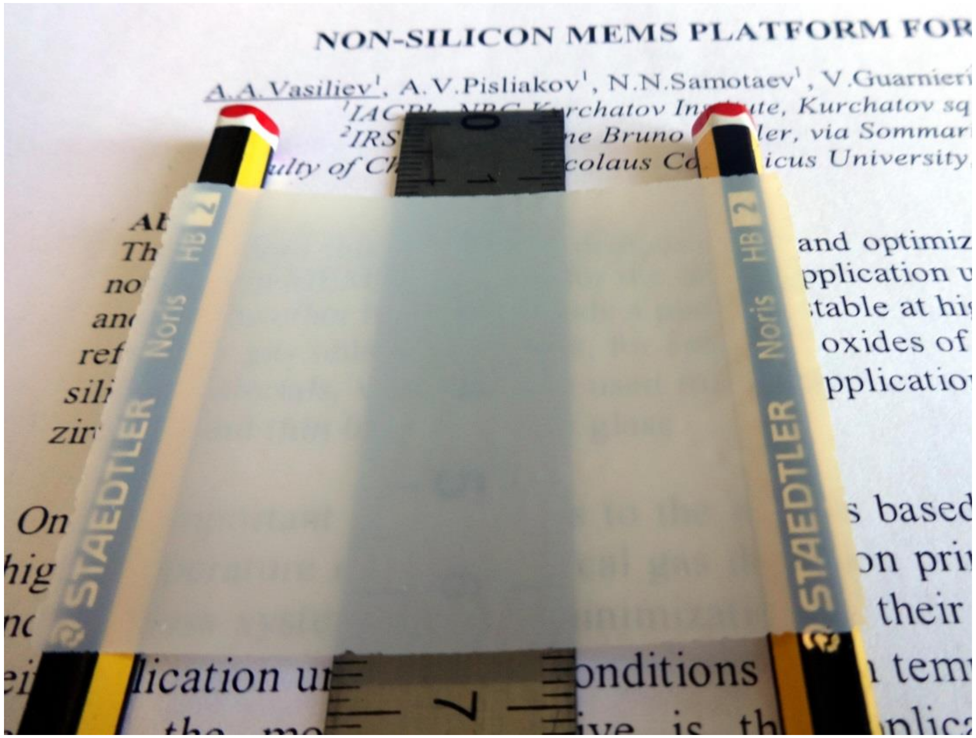
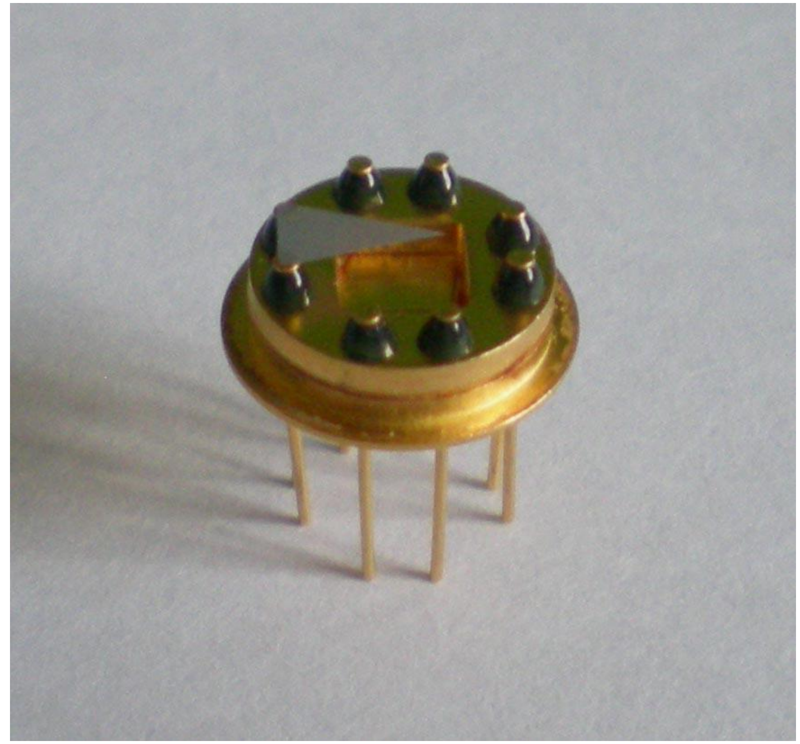
Alexey Vasiliev, Nat. Res. Center “Kurchatov Institute”, Moscow, RU

Substrates Made by Anodic Oxidation of Aluminum Foil

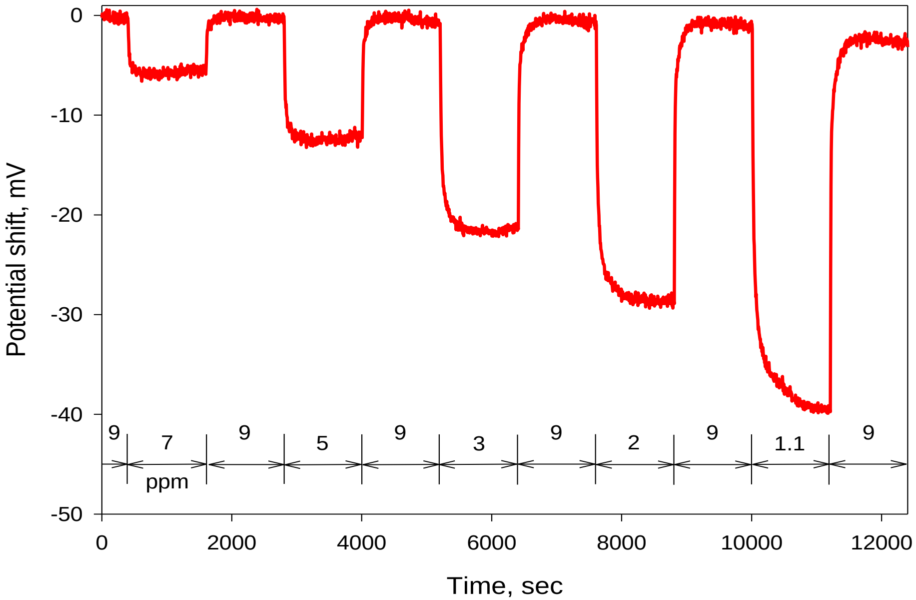


Alumina film (12 μm thick) prepared by anodic oxidation of aluminium followed by annealing at 800⁰C. Membrane size is of 48x60 mm.



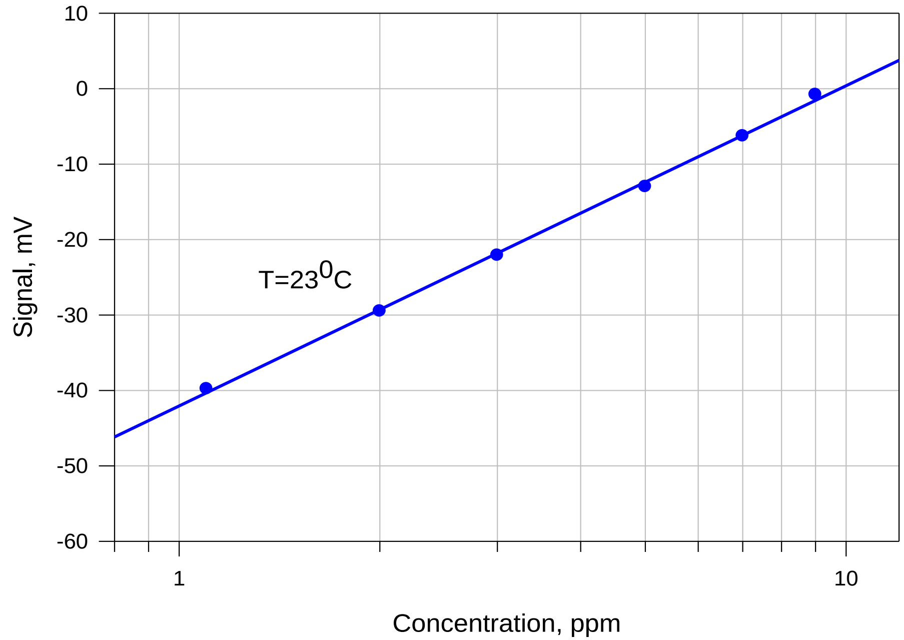
Alumina cantilever chip in TO8 package. Alumina film thickness is of 12 μm.

Response of MIS structure $Pt/LaF_3/SiO_2/SiC$ to HF at room temperature

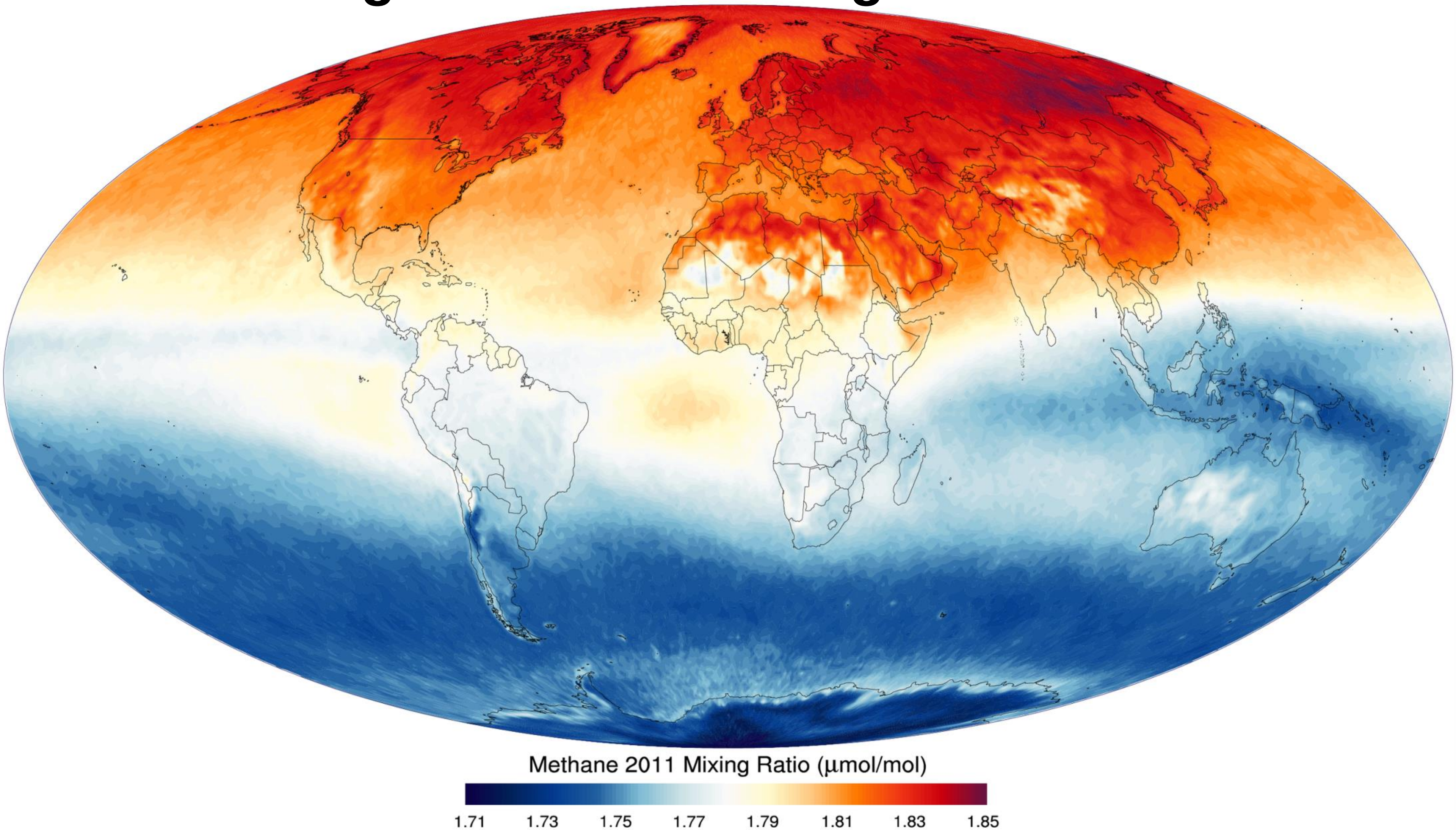


LaF_3 as sensing material for fluorides and fluorine containing compounds (Freon,…)

Sensitivity to hydrogen fluoride is of 45±3 mV/decade



Remote sensing of methane using LIDAR



LIDAR multispectral analysis setup in Sofia

Poster presentations

M. Schüler, P. Gaudillat, J.-M. Suisse, T. Sauerwald, M. Bouvet, A. Schütze: Enhanced Selectivity of MSDI Sensors for Ammonia Monitoring by Illumination Cycled Operation
Laboratory for Measurement Technology, Saarland University, Saarbruecken, Germany; Institut de Chimie Moléculaire de l'Université de Bourgogne, Dijon, France
→ Result of 2 EuNetAir STSMs

S. Andreev, N. Nikolov, M. Holz, C. Iroulart
Dynamically Driven Multi-Gas Sensor
FACET LTD, Sofia, Bulgaria; Mikrosistemi LTD, Varna, Bulgaria; Nanoanalytik Gmbh, Ilmenau, Germany; Efficience Marketing, Vanves, France
→ EU-Project IAQSense

M. Davidovic, D. Topalovic, D. Suriano, V. Pfister, M. Prato, M. Penza, M. Jovasevic-Stojanovic: Measuring Tobacco Smoke Air Pollution using High-Quality and Low-Cost Optical Particles Sizers
VINCA Institute, Belgrade, Serbia; ENEA, Brindisi, Italy
→ Particle sensing is still a big challenge for low-cost sensors