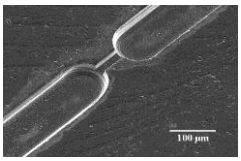


MIGRATE

MIniaturized Gas flow foR Applications with enhanced Thermal Effects

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No. 643095

MIGRATE (Research and training network on **MI**niaturized **G**as flow fo**R A**pplications with enhanced **T**hermal **E**ffects) is planned as a multi-partner Innovative Training Network (ETN – European Training Network), assessing research and applications for thermal aspects of gas microflows. The network consists of 10 beneficiaries and 7 associate partners, spread all over Europe. This unique combination of university research, SME and world leading industrial stakeholders will contribute in a synergetic way to the increase of knowledge about micro scale gas flow heat transfer problems as well as to industrial applications of highly efficient miniaturized devices. Within MIGRATE, a number of Early Stage Researcher (ESR) projects will cover different aspects of enhanced heat transfer and thermal effects in gases, spanning from modelling of heat transfer processes and devices, development and characterization of sensors and measurement systems for heat transfer in gas flows as well as thermally driven micro gas separators to micro-scale devices for enhanced and efficient heat recovery in automotive, aeronautics and energy generation.
The ESRs recruited for the network will undergo training in at least three different locations. Additionally, short stays can be arranged at beneficiaries and associate sites. Moreover, annual network wide workshops and summer schools will ensure that each researcher receives exposure to, and benefits from, the full expertise of the Network.

More information can be obtained from www.migrate2015.eu.

Within the MIGRATE network an

E S R Position (f / m)

is offered at the National Institute for Applied Sciences (INSA), Toulouse, France and
the Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany with the topic

Gas-Liquid Surface Micro Separators - VOCs trapping

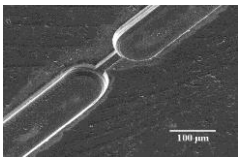
Ref. N°: MIGRATE-ESR 9

The position includes secondments at

IN'AIR Solutions (INR), Strasbourg, France (4 Months)

Politecnico di Milano (POLIMI), Milan, Italy (6 Months)

Short stays at the Institute of Chemistry and Processes for Energy, Environment and Health (ICPEES), Strasbourg, France are also foreseen.



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Main goal:
Development of a miniaturized gaseous formaldehyde micro-analyzer based on gas uptake into an aqueous reagent coupled to fluorescence or colorimetric detection in microfluidic devices. Liquid-surface-gas interactions will be modeled for the optimization of the gas uptake operating at low gaseous sampling flow. An upgraded version of an existing operational prototype for formaldehyde quantitative detection will be developed and tested.

Duration: 3 years

Expected starting date: 1-Sept-2016

Application deadline: **1-Jun-2016**

Support for housing, in terms of language courses etc. is provided by all participating organisations.

Application of women is highly appreciated!

Detailed description of the project:

Airborne Volatile Organic Compounds (VOCs) are compounds with high volatility in normal conditions of temperature and pressure, such as hydrocarbons, halogenated hydrocarbons, alcohols, ketones, aldehydes, amines, monoterpenes, etc. In recent years, detection of these pollutants in ambient air has gained importance due to their potential effects on human health and environmental pollution. Among these pollutants, formaldehyde is a major and harmful one of indoor air due to its multiple sources and its carcinogenic effect. Analytical instruments currently available on the market and enough sensitive for the real time quantification of formaldehyde are often sedentary or at best transportable, but never ultraportable. The development of ultra-portable, accurate and powerful analytical tools is thus a challenge to monitor in real time formaldehyde in various environments.

The main objective of this project is to develop a second version of an existing microfluidic analyzer allowing to sample and to detect formaldehyde, to obtain an ultraportable measuring instrument for the monitoring of indoor and outdoor air quality. Two partners of this project, ICPEES and INR, have indeed already jointly developed an analytical method based on three highly coupled steps (Guglielmino et al., 2014; 2015): 1) the uptake of gaseous formaldehyde into an aqueous solution using an annular two-phase flow; 2) the chemical reaction between formaldehyde and a selective derivative agent and 3) the fluorescence detection of the reaction product. More precisely, this work aims at improving the formaldehyde uptake yield, at reducing the response time of the instrument and the liquid reagent consumption.

It will thus be necessary in a first stage to study numerically and experimentally the two-phase annular flow in a capillary trapping tube, in order to determine and optimize the kinetics of the diffusion of gaseous species in the liquid phase. In addition, the model will be able to calculate the residence times of formaldehyde molecules in the different parts of the set-up, i.e. the uptake, reaction and detection modules. Such information will be useful for limiting the internal microfluidic volumes and then the liquid reagent consumption.
The following stage of the project will concern the design and manufacturing of the different microfluidic elements of the analyzer, including the detection cell and the gaseous uptake system in order to obtain a better sensitivity and a more robust apparatus respectively. A second formaldehyde microanalyzer prototype will finally be assembled and tested under controlled experimental

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conditions, i.e. accurate known gaseous and liquid formaldehyde concentrations. This instrument could then be deployed during indoor field campaigns for few days or weeks.

This project is a collaboration between 4 partners:

- The Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany, specialized in microstructure technology applied to micro process engineering (http://www.imvt.kit.edu/english/index.php).
- The National Institute of Applied Sciences (INSA), Toulouse, France (www.insa-toulouse.fr/en), specialized in experimental analysis of gas and liquid microflows (http://microfluidique.com/).
- IN'AIR Solutions (INR), Strasbourg, France (http://www.inairsolutions.fr/en/), a start-up that focuses on the development and commercialization of microanalysers for air quality diagnosis.
- Politecnico di Milano (POLIMI), Italy (http://www.aero.polimi.it/), specialized in mathematical and numerical modelling of fluid flows far from equilibrium and in kinetic theory of fluids.

The Early Stage Researcher will spend the majority of his/her time at KIT and at INSA Toulouse, with a 6-month secondment at POLIMI and 4-month secondment at INR. At the end of the project, the ESR will receive a double PhD Degree delivered by both the Karlsruhe Institute of Technology and the National Institute of Applied Sciences from Toulouse.

Expected time schedule

ESR n°9	Year 1	Year 2		Year 3	
	1st Stay	2nd Stay	3rd Stay	4th Stay	5th Stay
Location	**INSA**	**POLIMI**	**KIT**	**INR**	**KIT**

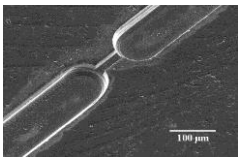
1st stay - INSA (12 months): Literature review on experimental techniques and numerical methods to analyse gas-liquid microflows. Numerical modelling of annular two-phase flow in a micro-tube, determination of geometrical and operating configurations leading to stable flow regimes. Preliminary experimental validations.

2nd stay - POLIMI (6 months): Numerical analysis, by Direct Simulation Monte-Carlo (DSMC) method, of the diffusion effects at the interface gas-liquid.

3rd stay - KIT (10 months): Design, manufacturing and preliminary tests of a microfluidic device, with specific thermal control, integrating the gas-liquid formaldehyde trapping microsystem, the chemical derivatization reaction and the fluorescence and/or colorimetric detection. This stage should in particular permit to identify a new robust material allowing the reproducible generation of an annular two-phase flow. This part will be carried out in close collaboration with INR which has developed a first formaldehyde analyser.

4th stay - INR (4 months): First validation of the upgraded prototype. In this stage, the PhD student could collaborate with another Migrate Early Stage Researcher (ESR 4 – Interferometric and colorimetric based sensing) supervised by INR and the University of Limerick.

5th stay - KIT (4 months): Complementary experiments on the complete prototype for drawing perspectives for optimizing the performances of the micro-analyser. Writing of the PhD thesis.



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Short visit(s): In addition, during periods spent at KIT or at INR, the Early Stage Researcher will have the possibility, during short visits of a few weeks, to use and to be trained on the analytical chemistry facilities provided by ICPEES Strasbourg (http://icpees.unistra.fr/en) for the measurement of formaldehyde in air at sub ppb levels.

Requirements

This is a challenging and highly rewarding course of study and therefore the successful candidate will need to have the following qualifications:

- Master-level (5 years) degree in Physics, Mechanical Engineering, Process Engineering or similar, with high standard results;
- very good background in fluid mechanics;
- excellent communication skills and written/verbal knowledge of the English language;
- high autonomy and adaptability skills;
- skills in CFD will be helpful;
- if the candidate has some experience in microfluidics and/or in experimental techniques adapted to fluid flows, as well as some knowledge on microstructure technology, this would be a benefit.

Financial information / Salary

Monthly gross salary including employer's contribution to social security: 3 452 € during stays in France (16 months); 3 073 € during the stays in Germany and Italy (20 months).
Annual mobility allowance: 7,200 € (researcher without family obligations) – 13,200 € (researcher with family obligations).

Application procedure:

Applications for this position have to include a detailed Curriculum Vitae with the contact details of three referees, a covering letter, attestation of the diploma / master degree and last transcript of records and they should be sent, using the reference number in the subject line via e-mail, to:

PD Dr.-Ing. habil. Juergen J. Brandner: juergen.brandner@kit.edu
and
Dr. Lucien Baldas: lucien.baldas@insa-toulouse.fr

Deadline: 01-06-2016

Eligibility of your application can be checked here: www.migrate2015.eu/