Virginia Vernocchi *(cycle XXXIV)*

Supervisor: *Prof. Paolo Prati*

PhD-project title: *Environmental and health effects of nanoparticles and bio-aerosol suspended in the atmosphere*
Preliminary title of Thesis: *Assessment of toxicity of particulate matter in the nano-metric range by an Atmospheric Simulation Chamber*

REPORT OF THE THIRD YEAR

- **SCIENTIFIC ACTIVITY**

During the third year of my PhD, I focused on the characterization of soot particles.
"Soot" refers to carbonaceous particles generated by incomplete hydrocarbons combustion. Soot particles are responsible for negative impacts, both on climate and health; therefore, it is necessary to understand their properties and behaviour in the atmosphere. For this purpose, the coupled use of a Mini-Inverted Soot Generator (MISG, Argonaut Scientific Corp., [1], [2]) and the Atmospheric Simulation Chamber ChAMBRe (Chamber for Aerosol Modelling and Bio-aerosol Research, [3]) is essential. The MISG is useful to generate soot particles with controlled and known properties, similar to the real soot particles in the atmosphere; ChAMBRe is a stainless steel chamber, having a volume of about 2.3 m^3, which allow studying atmospheric processes under realistic but controlled conditions, monitored in real time.

The experiments that I performed can be divided into three main series.
The first series of experiments, currently the widest, had several aims:
- To characterize the soot particles emitted by the MISG in terms of size distribution, particle and gas composition, optical properties.
- To compare particles generated by different combustion conditions (i.e. different air and fuel flow rates) for a selected fuel.
- To compare particles generated by the combustion of different fuels, in particular ethylene and propane.

Experiments were carried out by feeding the MISG with both ethylene and propane gases and varying the oxygen-fuel ratio. Online analyses were performed by a Scanning Mobility Particle Sizer (SMPS, TSI Inc., Model 3938) which measures the size distribution in the range 30-650 nm, three Photoacoustic extinctiometers (PAX, Droplet Measurement Technologies) which monitor the optical properties (Extinction, absorption and scattering) at λ = 870, 532 and 405 nm, and several gas analysers (Environnement SA, O_3, NOx, CO/CO_2, SO2 and BTEX). During each experiment, soot particles were collected on quartz fibre by a particulate matter sampler (Charlie - TCR Tecora). Filters underwent to optical and thermal-optical analysis. The optical characterization by the Multi-Wavelength Absorbance Analyzer (MWAA, [4]) allows the non-destructive determination of the spectral dependence of the absorption coefficient b_abs, and thus of the Ångström Absorption Exponent (AAE). The thermal-optical analysis, performed by a Sunset Lab Inc. EC/OC analyzer (Sunset Lab Inc.), provides the Elemental and Organic Carbon (EC and OC) concentrations, hence the EC/TC ratio (TC = Total Carbon).

The second series of experiments used the previous characterized particles to investigate their toxicological effects and the dose-response relationship. For this part, only a combustion condition was selected; soot particles were generated using both the fuels (ethylene and propane) and exposed to specific atmospheric conditions (standard and polluted). Generated soot particles were collected on filters in different loadings that will be analysed to retrieve information about oxidative potential and toxicology. The OP and toxicological analysis on filters were performed by external laboratories (CNR of Bologna, University of Milan and University of Rome).

The third series of experiments, still in progress, regards the interaction between soot particles and bio-aerosol. Two strains of bacteria (*Escherichia Coli* and *Bacillus Subtilis*) are exposed to soot particles generated by the propane combustion, with the aim of investigating how this affect the bacteria viability.

References

[1] M. Kazemimanesh et al.; *Aerosol Science and Technology* **2019**, 53 (2), 184-195.
[2] A. Moallemi et al.; *Journal of Aerosol Science* **2019**, 135, 46-57.
[3] D. Massabò et al.; *Atmos. Meas. Tech.,* **2018**, 11, 5885-5900.
[4] D. Massabò et al.; *Atmos. Environ.,* **2015**, 108, 1–12.

- **PUBLICATIONS**

- Vernocchi, V., Brunoldi M., Danelli, S.G., Massabò D., Parodi F., and Prati P.: *Characterization of MISG particles by an atmospheric simulation chamber.* TO BE SUBMITTED
- Danelli, S. G., Brunoldi, M., Massabò, D., Parodi, F., Vernocchi, V., and Prati, P.: *Comparative characterization of the performance of bio-aerosol nebulizers in connection with atmospheric simulation chambers,* Atmos. Meas. Tech., 14, 4461–4470, https://doi.org/10.5194/amt-14-4461-2021, 2021.

- **CONFERENCES**

- *Oral*: Vernocchi V., Brunoldi M., Danelli S.G., Massabò D., Parodi F., Prati P., Studio di particelle di soot in ChAMBRe, la camera di simulazione atmosferica, 107° Congresso Nazionale della Società Italiana di Fisica, online, 13-17 Settembre 2021.
- *Oral*: Vernocchi V., Brunoldi M., Danelli S.G., Parodi F., Prati P., Massabò D., Ethylene and Propane combustion in a Miniature Inverted Soot Generator: exhausts characterization through experiments at the ChAMBRe atmospheric simulation chamber, European Aerosol Conference EAC 2021, online, 30 Agosto - 3 Settembre 2021.

- **COURSES, EXAMS AND SCHOOLS**

All the exams have been completed in the last years.

- **OTHER COURSES**

- Programma di elevata formazione in “Sicurezza sul Lavoro” - **Corso di Formazione su Gas Compressi – Attrezzatura a pressione e Normativa PID** – INFORMA Formazione e Consulenza (2021)

Genoa, 07/09/2021