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 SECOND YEAR

- **SCIENTIFIC ACTIVITY**

Particulate Matter (PM) plays an important role in environmental pollution, human health and global climate changes. Sources and possible impacts of nanoparticles are widely diffused: in urban areas, several processes/sources emitting nanoparticles as carbonaceous compounds and titanium or silicon oxides are usually present.

Typically, atmospheric particles in the nm range are emitted by hydrocarbons combustion: a soot generator have been purchased to make possible systematic studies on the emission process. A soot generator is a stable source of soot nanoparticles. "Soot" refers to combustion-generated carbonaceous particles that are a by-product of incomplete combustion. To investigate how these particles behave in the atmosphere and their pathogenic load, in particular by experiments in an atmospheric simulation chamber (ChAMBRe, in this case), it is useful to generate soot particles with controlled and known properties and similar to the real soot particles in the atmosphere.

A considerable part of my activity during last year consisted in designing and then building an experimental set-up based on a specific Soot Generator (MISG, Argonaut Scientific, *Figure 1*). The Generator is fed with air and fuel (up to now ethylene and propane, in the future methane blend will be also used): gas flows are kept at the desired values by Mass Flow Controllers and a home-made LabView program. In the test set-up, the MISG is connected to a smaller model of the Atmospheric Simulation Chamber (approximately 1/100 of ChAMBRe volume). A Scanning Mobility Particle Sizer Spectrometer measures the size distribution of particles inside the chamber. The monitoring of temperature and relative humidity will be also implemented soon. The chamber is also equipped with a sampling line to collect the particles on a filter which undergoes off-line optical and thermal-optical analysis, leading to the quantification of elemental/organic carbon concentration.

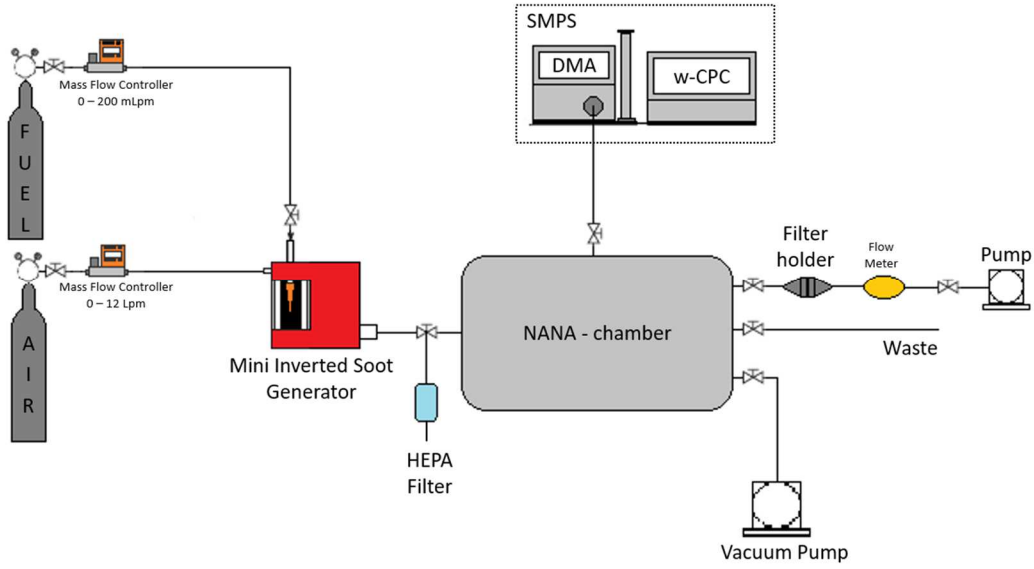


Figure 1: Experimental set-up.

Up to now a first bunch of tests has been performed starting to reproduce previous literature results on the characterization of emissions with ethylene [1] and propane [2]. The graphs below show an example of typical results. Figure 2 represents the size distributions of soot particles emitted by the MISG burning 3 lpm of air and 47 mlpm of ethylene. Figure 3 shows the optical behaviour (i.e. absorbance vs. wavelength of incident light) of the generated soot. The most important parameters, which also contain information on particle composition, are summarized the Table below: gas flows, global equivalence ratio (i.e. the ratio between actual and stoichiometric fuel to air ratio), ratio between elemental (i.e. inorganic) carbon (EC) and total carbon (TC) and Ångström Absorption Exponent (AAE, see fit in Figure 3). The experiments explored several configurations changing the air to fuel flow ratio: the results are going to be collected in an organized dataset.

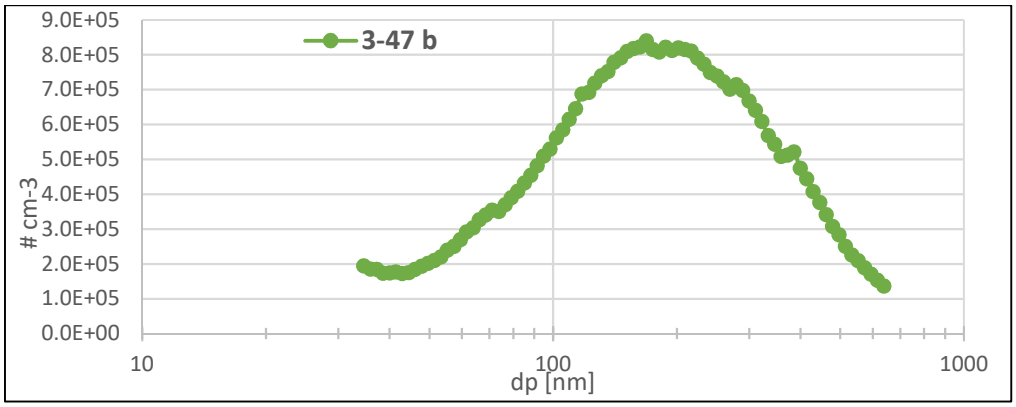
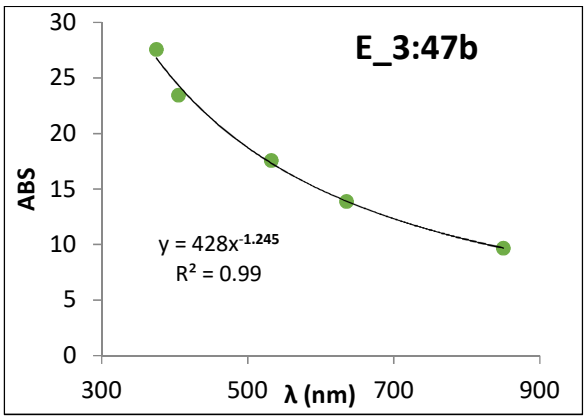


Figure 2: Example of size distribution of soot particles emitted by the MISG burning 3 lpm of air and 47 mlpm of ethylene.



Air Flow, [lpm]	3
Fuel Flow, [mlpm]	47
Global equivalence ratio ϕ	0.228
EC/TC	0.42
AAE	1.245

Figure 3: Example of the optical behaviour of the generated soot.

During the lock-down I focused on bibliographic research on the main topics of my PhD project:

- Particle counter and sizer (Optical Particle Sizer e Scanning Mobility Particle Sizer)
- Health effects of particulate matter
- Cell effects (i.e. oxidative stress) of particulate matter.

Furthermore, in preparation of the experiments at ChAMBRe, I collaborated to implement an automatic system (first order feedback) to control the chamber internal pressure, with a positive or negative gradient respect to the atmospheric pressure.

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.

- **CONFERENCES**

I got an oral contribution to a national conference (PM2020) and a poster to an international conference (EAC2020) but, due to the Covid-19 emergency, I did not attend any conference.

- **COURSES, EXAMS AND SCHOOLS**
  - Biofisica (exam given)
  - Instrumental techniques for the analysis of trace elements in pharmaceutical, food and environmental samples (exam given)

- **OTHER COURSES**
  - Corso Base di Tecnologie del Vuoto (16 h, AIV - Associazione Italiana Di Scienza E Tecnologia)

Genoa, 30/09/2020