



**HAL**  
open science

## Characterization of soot particles coming from aircraft and ship emissions: unique properties and impact on the atmosphere

Victoria Tishkova, Benjamin Demirdjian, Daniel Ferry, Olga B. Popovicheva, Jana Moldanova, Erik Fridell, Alessandro Faccinnetto, Cristian Focsa

### ► To cite this version:

Victoria Tishkova, Benjamin Demirdjian, Daniel Ferry, Olga B. Popovicheva, Jana Moldanova, et al.. Characterization of soot particles coming from aircraft and ship emissions: unique properties and impact on the atmosphere. CARBON 2009, Jun 2009, Biarritz, France. hal-03227978

**HAL Id: hal-03227978**

**<https://hal.science/hal-03227978>**

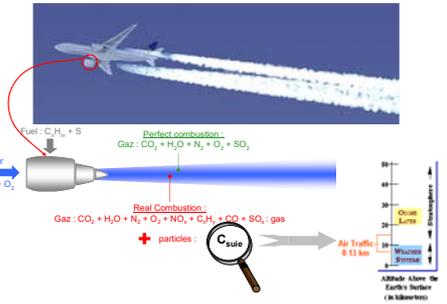
Submitted on 17 May 2021

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



FORMATION OF CARBON NANOPARTICLES (SOOT) IN THE ATMOSPHERE



THE SCIENTIFIC BACKGROUND

The low ability to predict climatic consequences (only qualitative estimates)  
 > The paucity of data about the physicochemical properties of aircraft engine soot  
 Most of studies, based on laboratory-generated soot particles  
 > show a large variation in their nucleation properties and reactivity.

This study is devoted to the comparison of laboratory soot / engine soot:

- morphology,
- microstructure,
- chemical composition,
- hygroscopic properties

⇒ determine the mechanisms responsible for the formation of CCN (contrails, clouds cirrus)

SOOT PRODUCTION

KEROSENE FLAME TC1 SOOT



Produced by burning aviation TC1 kerosene in a wick oil lamp



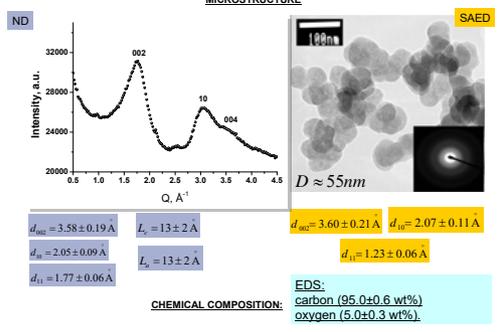
AIRCRAFT COMBUSTOR SOOT (collab. Aviation Institute, Moscow)



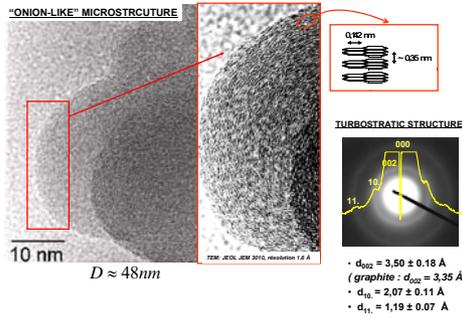
Aircraft engine	T <sub>fuel</sub> (K)	T <sub>comb</sub> (K)	Air / fuel ratio	Pressure (atm)
D30-KU	300	1250-1450	4 - 4.5	3 - 5

Aviation kerosene TC1 sulfur content: 1100 µg/g<sup>†</sup>

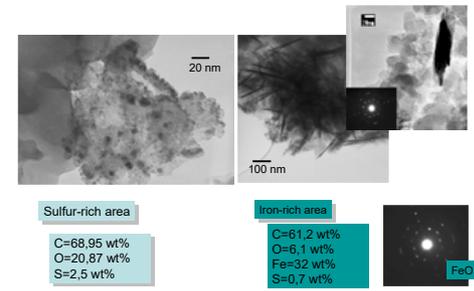
KEROSENE FLAME TC1 SOOT



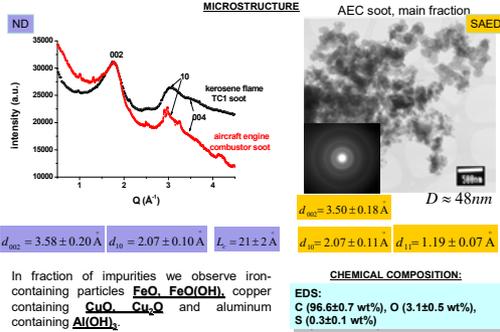
MAIN FRACTION OF AIRCRAFT ENGINE COMBUSTOR SOOT



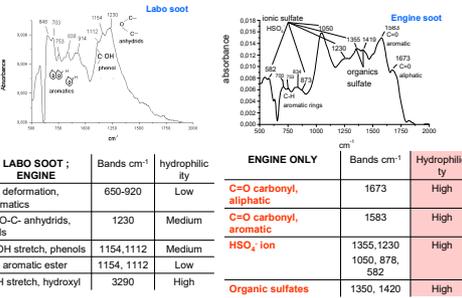
AIRCRAFT ENGINE COMBUSTOR SOOT: FRACTION OF IMPURITIES



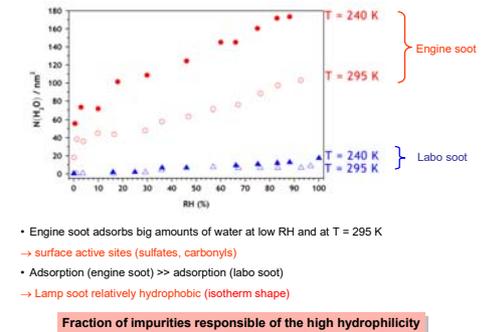
AIRCRAFT ENGINE COMBUSTOR SOOT



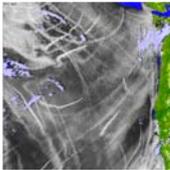
SOOT CHEMICAL COMPOSITION: FTIR (SURFACE FUNCTIONAL GROUPS)



WATER UPTAKE ON SOOT PARTICLES



SHIP EMISSION AND SAMPLING



- Possible climate impacts which are still least defined in comparison with land-based transport
- Ship emission particulates can act as nuclei for the formation of cloud droplets
- Ships may produce ship tracks

The starting point for evaluating the effect of ship emission on environment is to characterize its properties (like structure, chemical composition etc)

Water-soot interaction is one of the important parameters defining ability of the soot to form contrails and ship tracks

SAMPLING: MARINE DIESEL FUEL AND HEAVY FUEL OIL COMBUSTION RESIDUALS

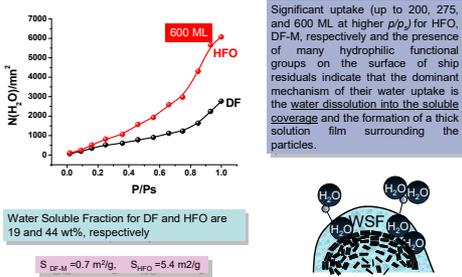


Sampled on board of the marine conveyor ships, burning diesel and heavy fuel oil.

Heavy Fuel Oil is a residual from crude oil refinement, after gasoline and distillate fuel oils are extracted through distillation. It typically contains sulfur up to 3.5 wt%, ash 0.1 wt%, vanadium 0.02 wt%, calcium 0.003 wt%.

Diesel fuel contains ash 0.01 wt% and sulfur 0.5 wt%

WATER UPTAKE ON DIESEL FUEL AND HEAVY FUEL OIL COMBUSTION PARTICLES



REFERENCES

Aircraft engine soot as contrail nuclei  
 O.B. Popovicheva, N.M. Persiantseva, E.E. Lukhovitskaya, N.K. Shonija, N.A. Zubareva, B. Demirdjian, D. Ferry, and J. Suzanne  
 Geophysical Research Letters 31 (11): Art. No. L11104 Jun 5 2004

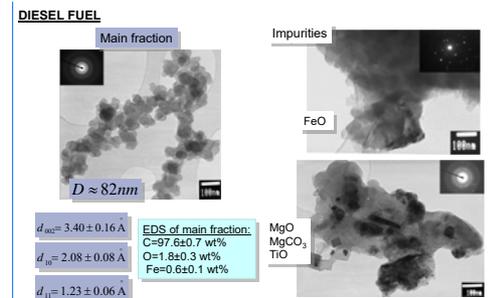
Heterogeneities in the microstructure and composition of aircraft engine combustor soot: impact on the water uptake.  
 B. Demirdjian, D. Ferry, J. Suzanne, O.B. Popovicheva, N.M. Persiantseva, N.K. Shonija, P. DelMott, K. Koehler, M. Petters, S. Kreidenweis, V. Tishkova, B. Demirdjian, and J. Suzanne  
 Journal of Atmospheric Chemistry, 56 (1) (2007) 85-103

Water interaction with hydrophobic and hydrophilic soot particles  
 O.B. Popovicheva, N.M. Persiantseva, N.K. Shonija, P. DelMott, K. Koehler, M. Petters, S. Kreidenweis, V. Tishkova, B. Demirdjian, O. Popovicheva, E. Kereeva, N. Persiantseva, T. Khokhlova, N. Shonija, V. Tishkova, and B. Demirdjian  
 Atmospheric Research 90 (2008) 328-337

Effect of soot on immersion freezing of water and possible atmospheric implications  
 O. Popovicheva, E. Kereeva, N. Persiantseva, T. Khokhlova, N. Shonija, V. Tishkova, and B. Demirdjian  
 Atmospheric Research 90 (2008) 328-337

Characterisation of particulate matter and gaseous emissions from a large ship diesel engine  
 Jana Moldanova, Erik Fridell, Olga Popovicheva, Benjamin Demirdjian, Victoria Tishkova, Alessandro Faccinetto and Cristian Focsa  
 Atmospheric Environment 43 (2009) 2632-2641

MICROSTRUCTURE AND CHEMICAL COMPOSITION OF DIESEL FUEL AND HEAVY FUEL OIL EMISSION RESIDUALS



HEAVY FUEL OIL

