# Spectroscopic Analysis of Black-Carbon Emissions from Aviation Sources

Li-Lin Tay[1], Meghdad Saffaripour[1], Greg J. Smallwood[1] and Kevin Thomson[1]

[1]*National Research Council Canada, Ottawa, ON, K1A0R6 Canada*

*Corresponding e-mail address: lilin.tay@nrc-cnrc.gc.ca*

**Black carbon (BC) emissions from commercial aviation sources are growing concern because of their potential impacts on both human health and climate. BC alters the Earth's radiation budget directly by absorbing and scattering the incoming solar radiation. Optical properties of BC particles depend strongly on their chemical bond structure as well as their size and morphology. To obtain reliable BC mass concentration in the aviation exhaust emission using optical instruments, it is essential that the BC particles used for instrument calibration has similar optical properties to those emitted from the engine being tested. In this paper, Raman spectroscopy, is used to characterize BC particles from various aviation engines. Finding of this analysis is useful in identifying suitable BC sources for the calibration of optical instruments.**

## THE FIRST SECTION

Black carbon (BC) aerosol, often termed soot, is a dominant form of light absorbing fine particulate matter in the atmosphere. BC emission from combustion processes poses significant health and environmental concerns. Its strong absorption response to the solar radiation implicates the heating of both atmosphere and highly reflective surfaces, such as snow and ice. These effect has important consequences on the climate change. Transportation is considered the largest anthropogenic sources of BC emission in Canada which includes emissions from aviation aircraft. BC aerosol emitted by aircraft strongly absorb solar radiation and have a long lifetime relative to near-surface BC emissions. They also act as vapour condensing nuclei which initiate contrails to further affect the radiative properties of clouds. In addition, aviation-induced cloudiness plays a role in the degradation of air quality in the vicinity of airports. To better understand and assess these undesirable impacts, accurate and quantitative measurement of soot emissions from aircraft engines is crucial. The optical instruments that are commonly used to measure soot mass concentration of aircraft emission have a strong dependence on the optical properties of the soot particles. The instruments are often calibrated with the laboratory generated surrogated soot particles. In this presentation, we will discuss the use of an optical spectroscopy measurement that is used extensively in the nanocarbon characterization, Raman spectroscopy, to identify a suitable soot calibration sources with the optical properties closely resembles those emitted from aviation engines.

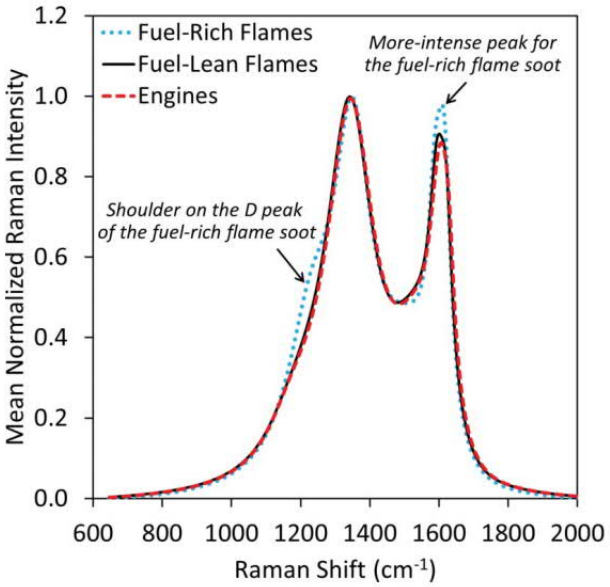


Figure 1. A comparison between the normalized averaged Raman spectra of the soot emitted from the fuel-rich flames, fuel-lean flames and aricraft turbin engines. The two notable features identified by arrows shown signifies differences in BC nanostructure. It is used to guide laboratory soot generation condition to produce BC particles with similar optical properties to those originated from aircraft engines.

## REFERENCES

1. M. Saffaripour, L.-L. Tay, K. A. Thomson, G. J. Smallwood and M. Johnson, "Raman spectroscopy and TEM characterization of solid matter emitted from soot generators and aircraft turbine engines", *Aerosol Science and Technology*, **51** (4), 518-531, 2017