Laser Vaporisation Aerosol Mass Spectrometry for In-flight Characterisation of Engineered Nanoparticles and Black Carbon Containing Aerosol

Nilsson, P.T; Eriksson, Axel; Ludvigsson, Linus; Messing, Maria; Deppert, Knut; Onasch, T. B.; Pagels, Joakim

2014

Link to publication

Citation for published version (APA):

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
• You may not further distribute the material or use it for any profit-making activity or commercial gain
• You may freely distribute the URL identifying the publication in the public portal

Take down policy
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.
Laser Vaporisation Aerosol Mass Spectrometry for In-flight Characterisation of Engineered Nanoparticles and Black Carbon Containing Aerosol

P.T. Nilsson1, A.C. Eriksson2, L. Ludvigsson3, M.E. Messing3, K. Deppert3, T.B. Onasch4 and J.H. Pagels1

1Ergonomics and Aerosol Technology, Lund University, P.O. Box 118, SE-22100, Lund, Sweden
2Nuclear Physics, Lund University, P.O. Box 118, SE-22100, Lund, Sweden
3Solid State Physics, Lund University, P.O. Box 118, SE-22100, Lund
4Aerodyne Research Inc. Billerica, MA, USA

Keywords: Black Carbon, AMS, Metal Particles

The chemical properties of nanoparticles (NPs) are important for technical applications as well as effects on health and climate. The effects commonly depend on both the core particle properties and surface coatings-functionalisations (for example organic). It is desirable to characterise the chemical composition of nanoparticles “in-flight” to minimise biases related to particle collection and storage prior to offline analysis as well as achieving a high time resolution.

A Laser Vaporisation Aerosol Mass Spectrometer (LV-AMS), was recently developed primarily for detection of absorbing refractory aerosol in ambient field measurements (Onasch et al. 2012). Here we describe how this technique can be used to separately characterize the chemical core and coating properties of two cases of particles: 1) Metal nanoparticles synthesized in a nanotechnology laboratory and 2) Black carbon containing combustion aerosols.

In the LV-AMS particles are focused while still airborne from ambient conditions to a vacuum chamber using an aerodynamic lens inlet. A continuous wave Nd-YAG laser (1064 nm) is used for particle vaporization. The technique is selective for particle materials absorbing at this wave length, e.g. black carbon and metals. Vaporized molecules from the particle are then ionised using electron ionization (70 eV) and detected in a high resolution time of flight mass spectrometer.

Two methods for production of metal ENPs were used in a clean room laboratory, a spark discharge generator and a high temperature furnace. For particle size selection a tandem-DMA set-up was used with the possibility to sinter the freshly formed agglomerates into almost spherical shapes. In addition black carbon containing particles from a diesel engine and flame soot generators were investigated. The LV-AMS was used in parallel with a CPC and an aerosol particle mass analyser (APM) to investigate the instrument sensitivity as a function of particle size, shape and composition.

Traces of organic impurities/surface coatings could be quantified in the generated metal particles and the organic mass fraction depended upon particle size and shape/processing. The composition of the organic impurities depended upon particle generation technique, processing and particle material.

Metal ions were detected for Ag, Au, Pd, Fe and mixed PdAg alloy NPs. For the Fe nanoparticles, metal oxide ion signals were detected indicating that these particles were already partially oxidized in the gas-phase. On-going work aims towards quantification of the metal signals.

Measurements on refractory black carbon particles from combustion systems showed three main classes of fragments: 1) CxHy+ clusters that can be associated with the primary organic coating. 2) Cx+ fragments that can be associated with the soot core. However, in addition all investigated soot sources showed significant amounts of a third class containing COx+ fragments that represents refractory oxygen containing species. Both Cx+ and COx+ fragments are absent when utilizing the conventional tungsten vaporizer at 600 C in the AMS and can thus be termed refractory and associated with the soot core.

This work was supported by the nanometer structure consortium at Lund University (nmC@LU) and the Swedish Research Council FORMAS.