Characterization of Few-Layer Graphene Nanoparticle Aerosols by Laser-Induced Incandescence

Supplementary data

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LII signal contamination measurements

TiRe-LII data is usually analyzed assuming that the measured spectral intensity is solely due to incandescence of the thermally-excited nanoparticles, but this is not always true. In the case of soot, for example, under certain measurement conditions the LII data collected over the detection wavelength range may become contaminated with emission from polyaromatic hydrocarbons (PAHs) and other volatile compounds [1,2], as well as emission from evaporated carbon clusters [3,4]. The detected signal may also be affected by absorption of incandescence by PAHs and other gaseous compounds present on the aerosol. A series of test experiments were carried out at the University of Duisburg-Essen to determine whether the presence of gaseous byproducts of the synthesis could influence the detected few-layer graphene (FLG) LII spectrum. A PTFE-coated filter membrane was installed upstream the measurement cell, allowing only volatile components to pass and reach the test cell. No LII signal was detected with this configuration, neither using PMTs nor with streak camera—spectrometer. That proves that there were no gaseous species in the aerosol absorbing 1064 nm laser radiation.

Additional line-of-sight attenuation (LOSA) measurements were carried out with the same setup configuration (PTFE-filter upstream the measurement cell) using a broadband light source with a diffuser plate (LDLS EQ-99X, Energetiq Technology Inc.) [5]. The light from the light source was guided through the measurement cell with and without gas stream present, and the resulted light absorption was measured using an EM-CCD camera—spectrometer (Andor iXon DV887—Acton SP-150, Oxford Instruments). No absorption between 350–820 nm was detected, which is the indication that there were no gaseous species in the aerosol that absorb, and hence emit, radiation between 350–820 nm.

Finally, we installed a quadrupole mass spectrometer (HALO 301, Hiden Analytical) downstream the filter membrane to monitor gaseous components with masses up to 300 amu during the synthesis. No components having a mass larger than 50 amu were observed, meaning that no large gaseous components capable to absorb and emit in the detection wavelength range were present in the test cell during LII measurements.

Laser energy profiles

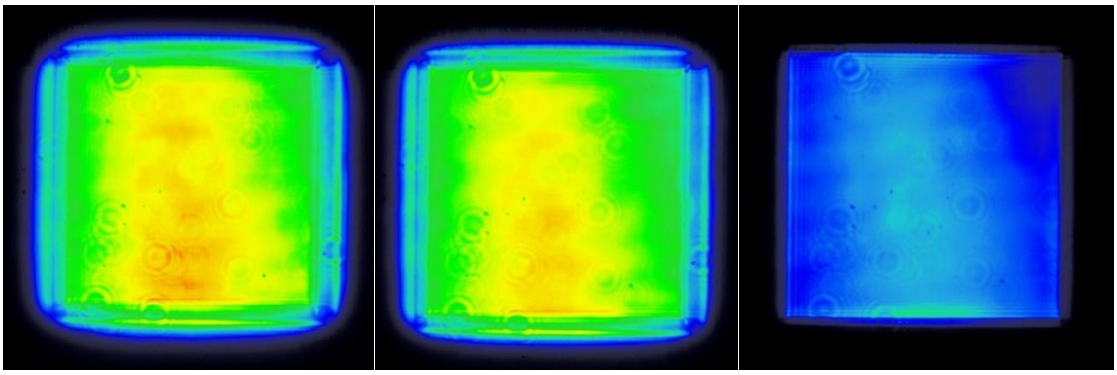

Fig. S1. Laser energy profiles of the LII-300 instrument (Artium Inc.) used for the measurements at the National Research Council Canada's Metrology Research Centre, Ottawa, Canada.

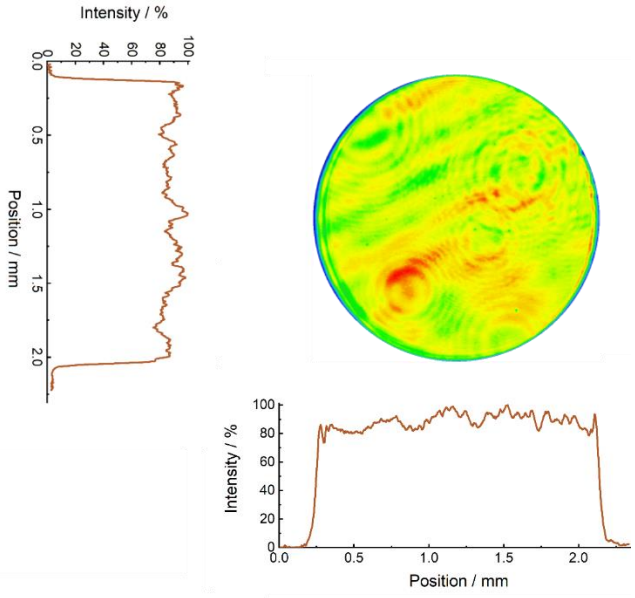

Fig. S2. Laser energy profiles of the Powerlite 7000 (Continuum) laser used for the measurements at the University of Duisburg-Essen, Duisburg, Germany.

TEM Characterization

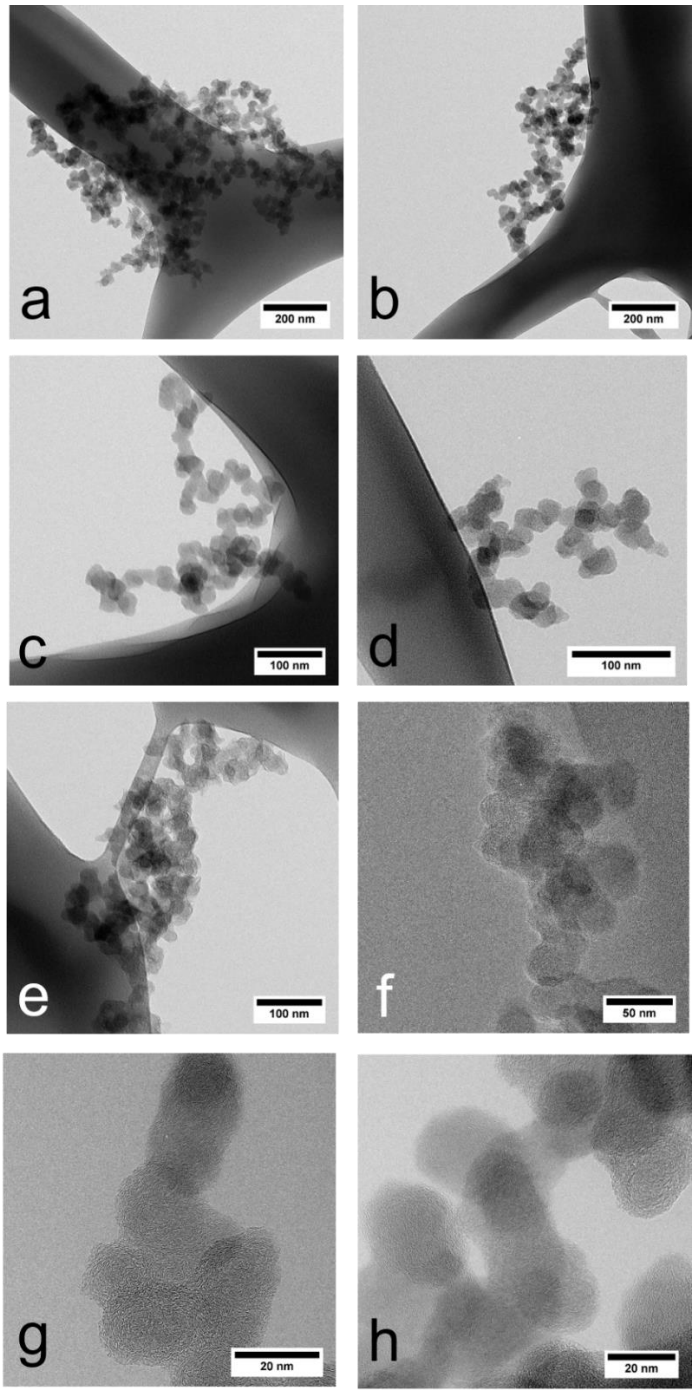

Fig. S3. a-h) TEM images of soot nanoaggregates produced in the plasma reactor from vaporized toluene.

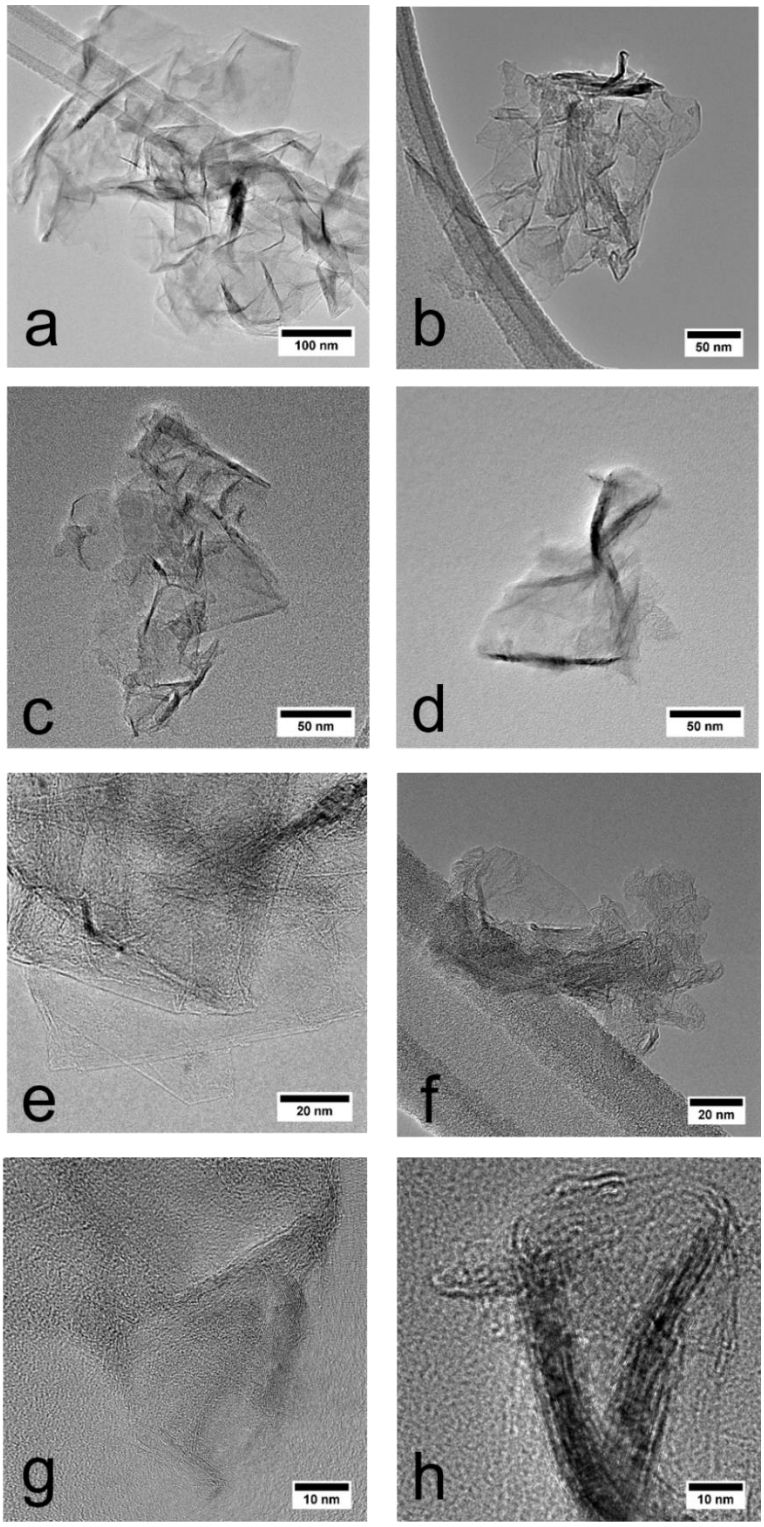
a
100 nm
b
50 nm
c
50 nm
d
50 nm
e
20 nm
f
20 nm
g
10 nm
h
10 nm

Fig. S4. a-h) TEM images of nebulized FLG nanoparticles sampled with an electrostatic precipitator ESPnano-100.

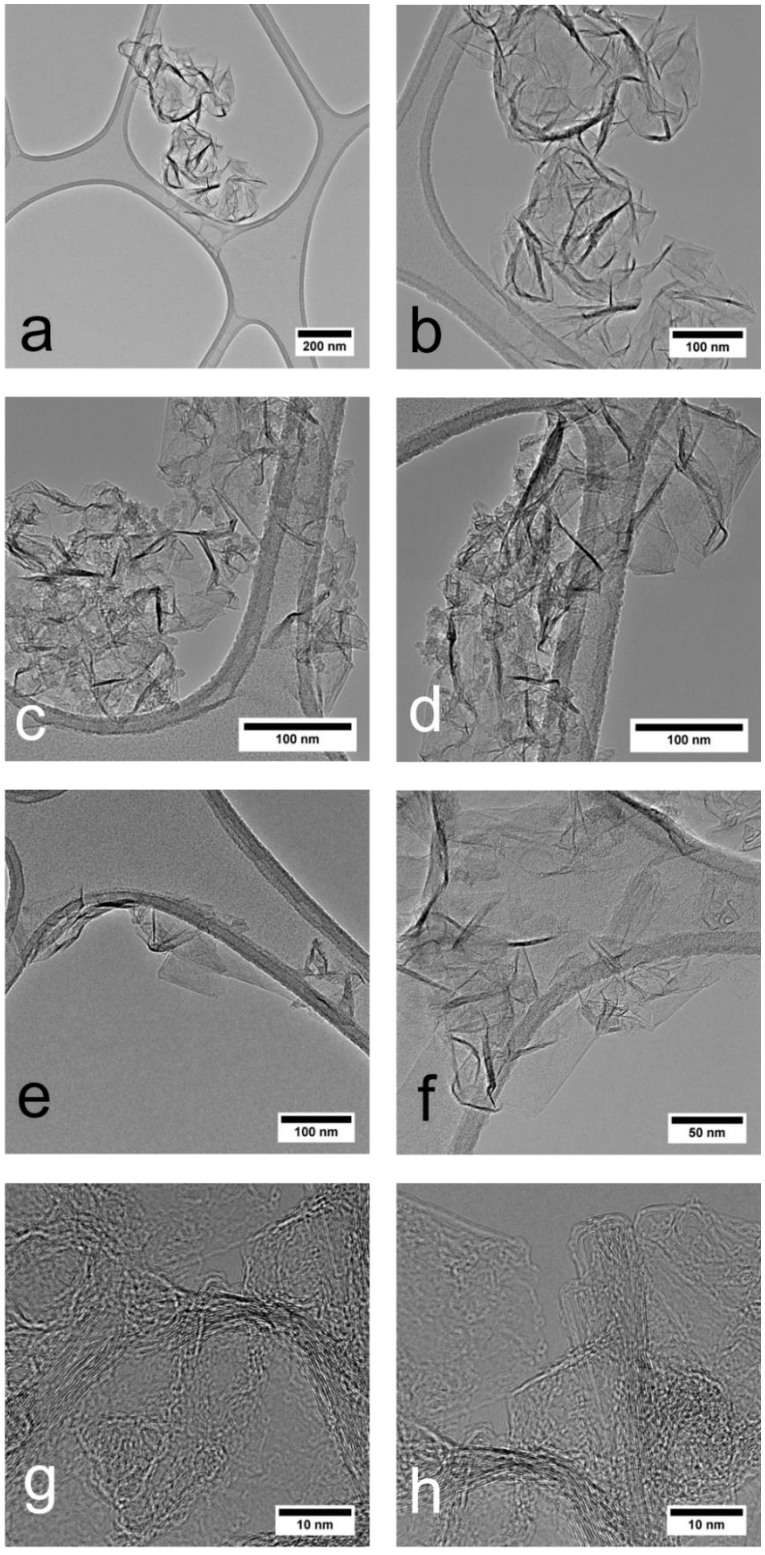

Fig. S5. a-h) TEM images of FLG nanoparticles sampled from the FLG/ethanol colloid.

Raman Spectroscopy of soot nanoaggregates

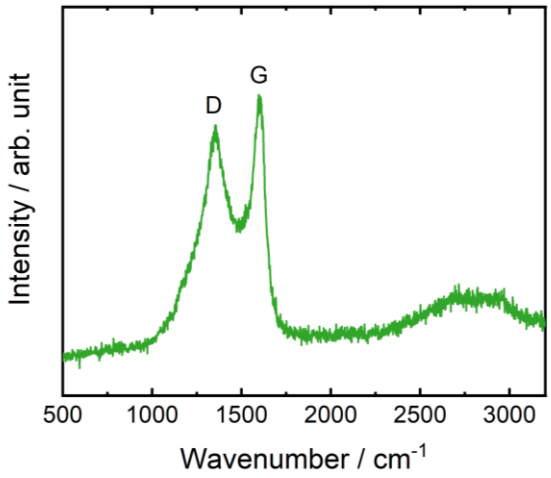

Fig. S6. Raman spectrum of a soot nanoaggregates powder sample.

Scanning Mobility Particle Sizing and Dynamic Light Scattering

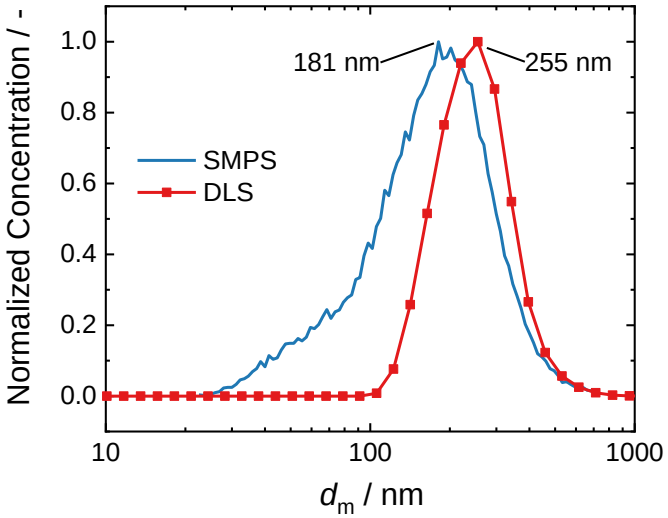

Fig. S7. Nebulized FLG particles mobility diameter distribution measured with a scanning mobility particle sizer (SMPS) and the size distribution of FLG particles in the ethanol colloid measured using dynamic light scattering (DLS).

References

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