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

Stanislav Musikhin [a,b]
Paolo Fortugno [a], Joel C. Corbin [c], Greg J. Smallwood [c], Thomas Dreier [a], Kyle J. Daun [b], Christof Schulz [a]
[a] Institute for Combustion and Gas Dynamics – Reactive Fluids and Center for Nanointegration Duisburg Essen, University of Duisburg-Essen, Duisburg, 47057, Germany
[b] Department of Mechanical and Mechatronics Engineering, University of Waterloo, Waterloo, N2L 3G1, Canada
[c] Metrology Research Centre, National Research Council Canada, Ottawa, K1K 2E1, Canada
stanislav.musikhin@uni-due.de

The numerous possible applications of few-layer graphene (FLG) create a demand for large-scale synthesis for this material. One of the promising routes is the gas-phase synthesis of FLG aerosols that is capable of producing large amounts of high-quality material [1]. Optimizing the gas-phase synthesis requires a detailed understanding of the graphene formation kinetics, which in turn demands diagnostics for characterizing FLG aerosols *in situ*. Laser-induced incandescence (LII), a laser-based nanoparticle characterization technique, is ideal for this purpose, due to its high temporal and spatial resolution, and the fact that it requires optical but not physical access to the aerosol. LII involves heating nanoparticles with a short laser pulse to incandescent temperatures and detecting the spectral incandescence from the particles while they cool down to the ambient temperature. Various aerosol properties can be inferred through the analysis of the detected incandescence signals.

In this work, FLG powder was formed via a gas-phase microwave-plasma synthesis route using vaporized ethanol as a precursor. *Ex situ* analysis showed that the powder consisted of highly structured few-layer graphene flakes without contamination. FLG sample was dispersed in ethanol, nebulized with a pneumatic nebulizer, and investigated by LII.

We show that LII can be used to measure FLG aerosol concentration *in situ*, monitor the particle surface area, and differentiate FLG from soot particles that may also form during the synthesis process [2].

REFERENCES

[1] A. Münzer,, L. Xiao,, Y.H. Sehlleier,, C. Schulz,, H. Wigger, Electrochimica Acta 272 (2018) 52–9
[2] S. Musikhin, P. Fortugno, J.C. Corbin, G.J. Smallwood, T. Dreier, K.J. Daun, C. Schulz, Carbon 167 (2020) 870–80

FIGURES

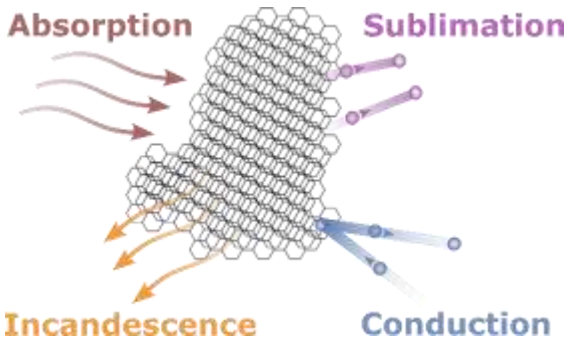

Figure 1: Heat and mass transfer processes underlying laser-induced incandescence on a few-layer graphene.