

University of Nottingham



nmRC CASE STUDY

SOOT-IN-OIL DIAGNOSTICS

nmRC_CS_08





Soot-in-Oil Diagnostics

Transmission Electron Microscopy (TEM) & Nanoparticle Tracking Analysis (NTA) Case Study



- A build-up of soot in engine oil reduces performance.
- Oil thickening increases viscosity, raising CO₂ emissions and fuel consumption.
- Increased engine wear occurs as anti-wear additive effectiveness is reduced.
- Level of wear depends upon the characteristics of the particles and agglomerates of soot.

The understanding of soot-in-oil characteristics and their impact is impeded by the limitations of experimental techniques for soot analysis



- The size distribution and morphology of soot particles is critical.
- Influences oil properties and gives insight into particle formation and growth.
- Better characterisation should help develop strategies to combat engine wear.

Novel strategies have been developed using the application of specialist imaging analytics.

- Transmission Electron Microscopy (TEM)
 - Nanoscale Visualisation
 - Particle and Feature Sizing
- Nanoparticle Tracking Analysis (NTA)
 - 'In-situ' Particle Size Distribution





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- An electron microscopy technique with Ångstrom resolution capability.
- It uses the contrast in electron transmission as a beam passes through ultra-thin specimens to generate an image of soot particulates.





Particle sizing and morphology

Frequency, size distribution, structure

etc. of nanometre structures

Structure of primary particles

High resolution (HRTEM) imaging identifies molecular structures e.g. inner core, graphitic layers, outer shell crystallites



- A technique used to size nanoparticles (10-2000 nm) and evaluate concentrations in liquid samples.
- A laser beam illuminates the particles, causing them to act as point scatterers, and an optical microscope with camera visualises and records the path of the particles under Brownian motion.



'In-situ' analysis Nanosight LM14 at the nmRC



Nanoparticle size distributions and concentrations *Batch to batch comparisons of particle size distributions and concentrations.*



- Soot-in-oil contamination reduces engine performance.
- Characterisation of size distribution and morphology of such contamination has been limited.
- TEM and NTA offer novel diagnostics of nanoparticulate soot-in-oil contamination.
- Soot particle size distributions, concentrations and structural assessments were recorded.
- Soot particle contamination of engine oil was better characterised, opening the door for the development of prophylactic strategies and screening processes.
- Click right to see a 3D image of a soot particulate built from TEM imaging.







For more details on the work showcased in this case study see the following publications:

A. La Rocca, G. Di Liberto, P.J. Shayler, C.D.J. Parmenter, M.W. Fay. Application of nanoparticle tracking analysis platform for the measurement of soot-in-oil agglomerates from automotive engines. Tribology International 70 (2014) 142–147

The transmission electron microscopy (TEM) and nanoparticle tracking analysis (NTA) documented here were performed at the Nanoscale and Microscale Research Centre (nmRC) at the University of Nottingham. www.nottingham.ac.uk/nmrc





- We hope the information provided in this case study is of interest.
- If you wish to get in touch with us to discuss any of the information provided, raise a query/concern or provide feedback then please use any of the methods listed below:

nmRC Commercial Services Nanoscale & Microscale Research Centre University Park Nottingham NG7 2RD

Telephone:+44(0)115 951 5046Email: nmcs@nottingham.ac.ukFax:+44 (0)115 846 7969Website:www.nottingham.ac.uk/nmrc-commercial