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nmRC CASE STUDY

PERFORMANCE FUEL ENGINEERING

nmRC_CS_06



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Performance Fuel Engineering

Time-of-Flight Secondary Ion Mass Spectrometry
(ToF-SIMS) Case Study

Innospec Ltd.



Recent advances in diesel fuel injection equipment coupled with ultra-low-sulfur diesel (ULSD) and biodiesel blends.



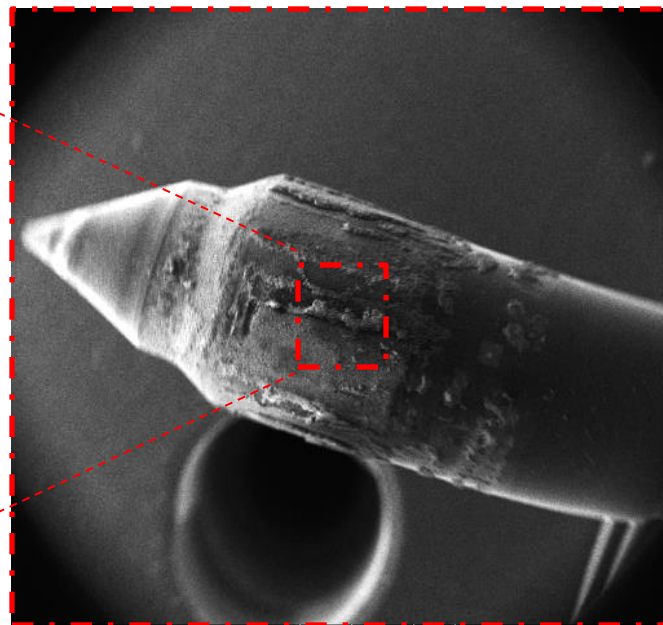
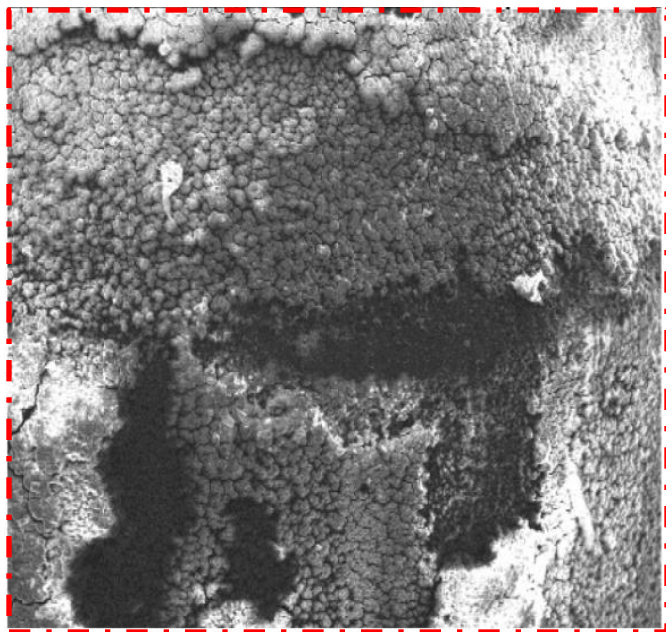
Increase in fuel system deposit formation issues from both engine manufacturers and fleet operators.



INJECTOR CONTAMINANTS



- Internal deposits on diesel fuel injectors have become prevalent and problematic to function.
- These have not been well characterised.

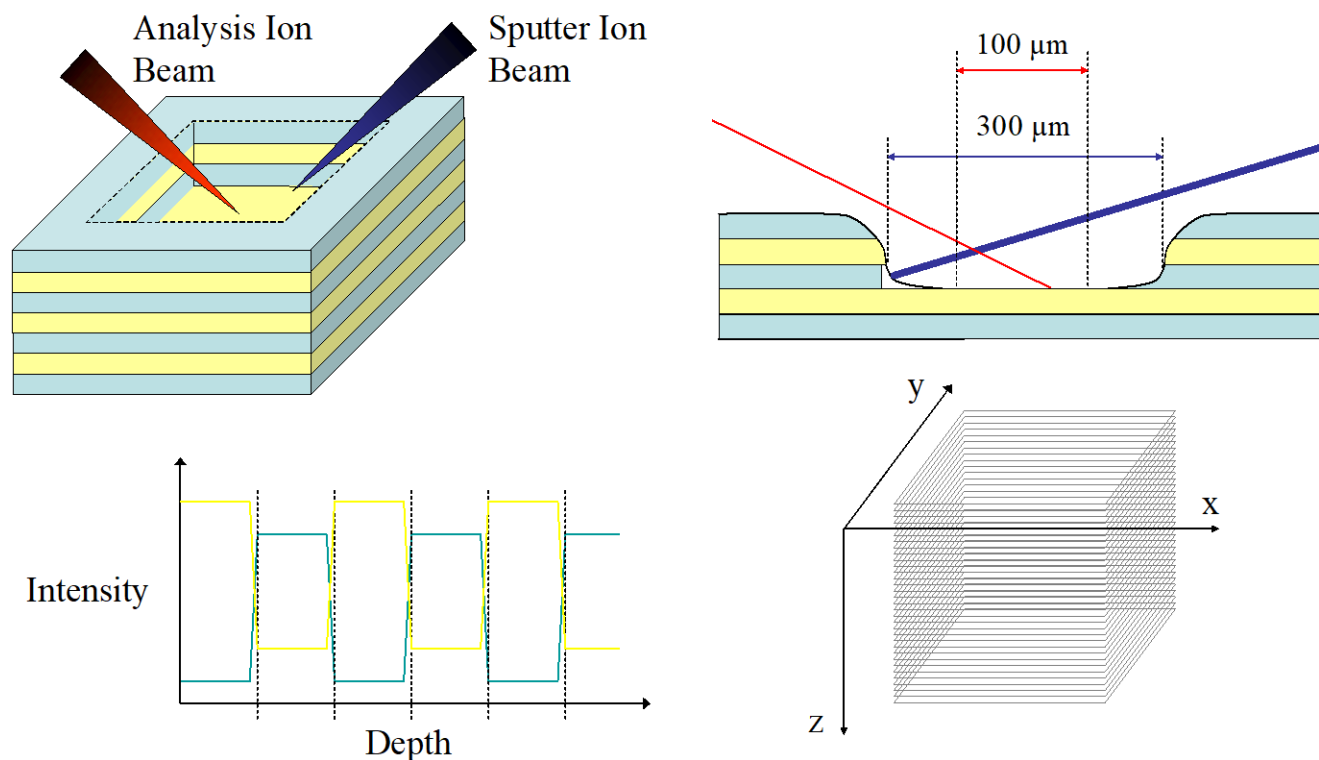


- Deposits are different from those traditionally encountered, with inorganic and carbon components being found.
- Deposits can eventually accumulate in the fuel filters and lead to significant performance issues.
- Critical to understand their genesis and structure to combat the process.

➤ **What are the constituents?**

➤ **How are they structured?**

- Time-of-Flight Secondary Ion Mass Spectrometry (ToF-SIMS) can chemically analyse surfaces in x, y and z.
- Application of high primary ion dose sputtering ion (Cs^+) gives successive removal of top surface layers.
- Use of secondary, static analysis beam (Bi_3^+) to map distribution of constituent ions with depth.

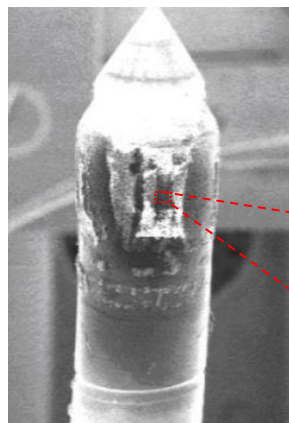
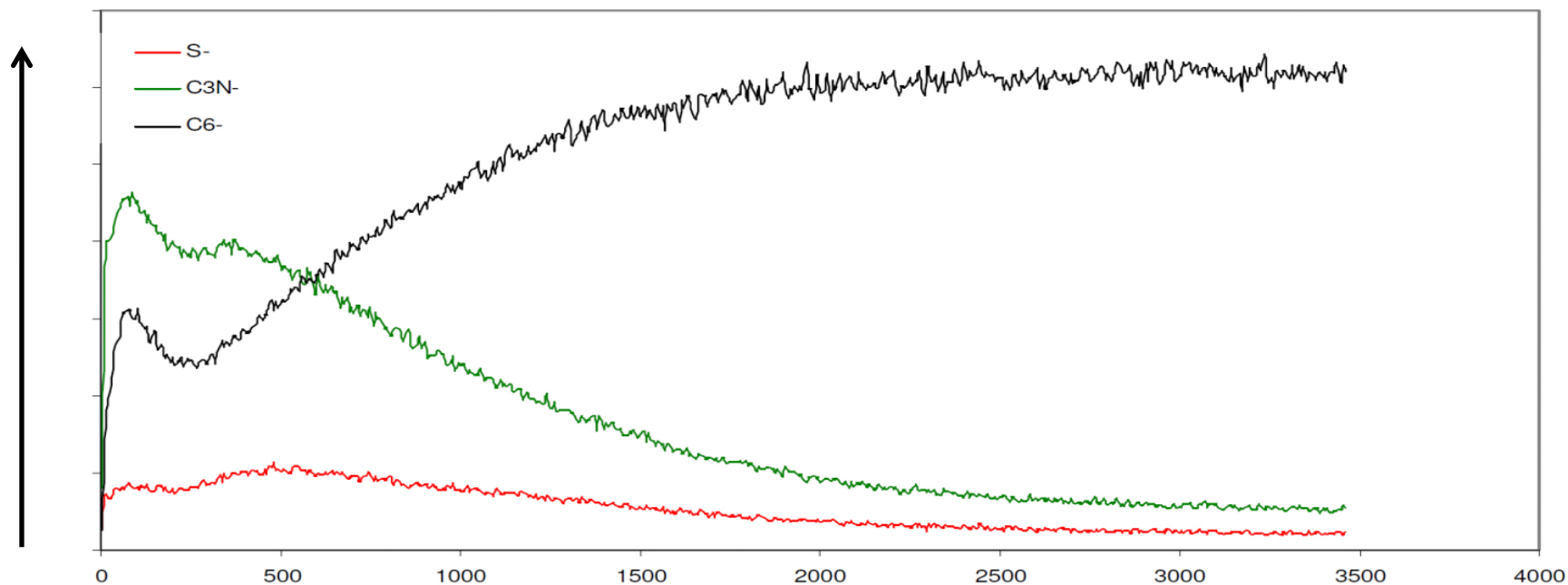




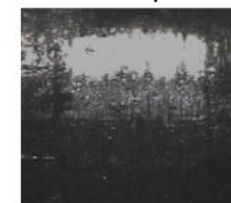
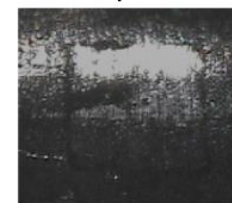
ToF-SIMS DEPTH PROFILE



Ion Intensity
(Presence)

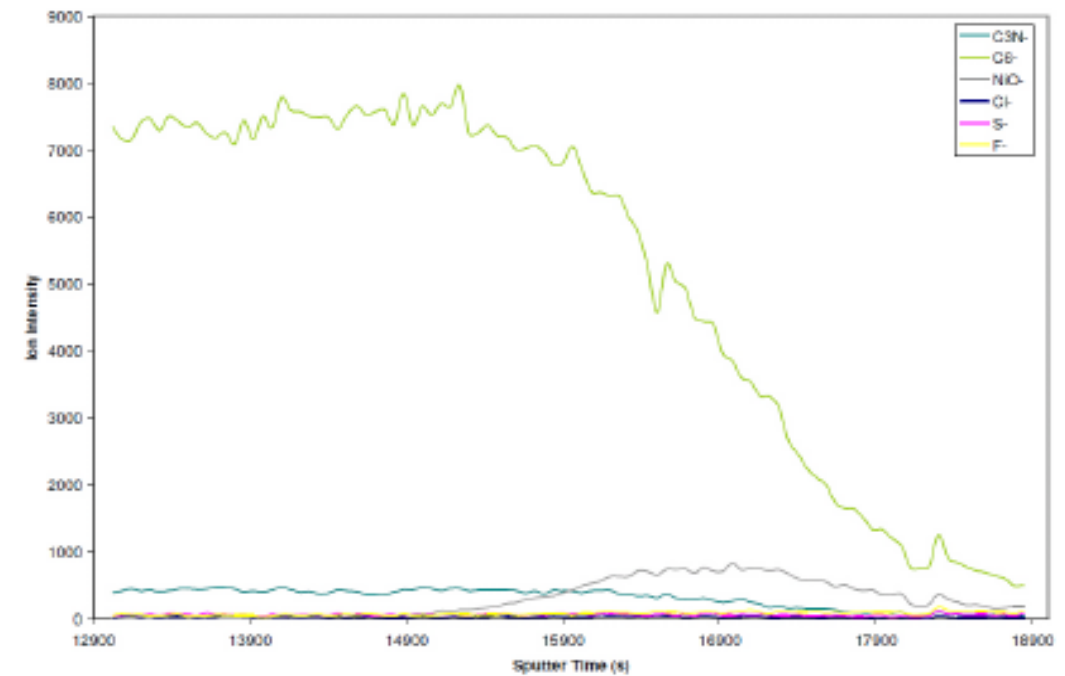
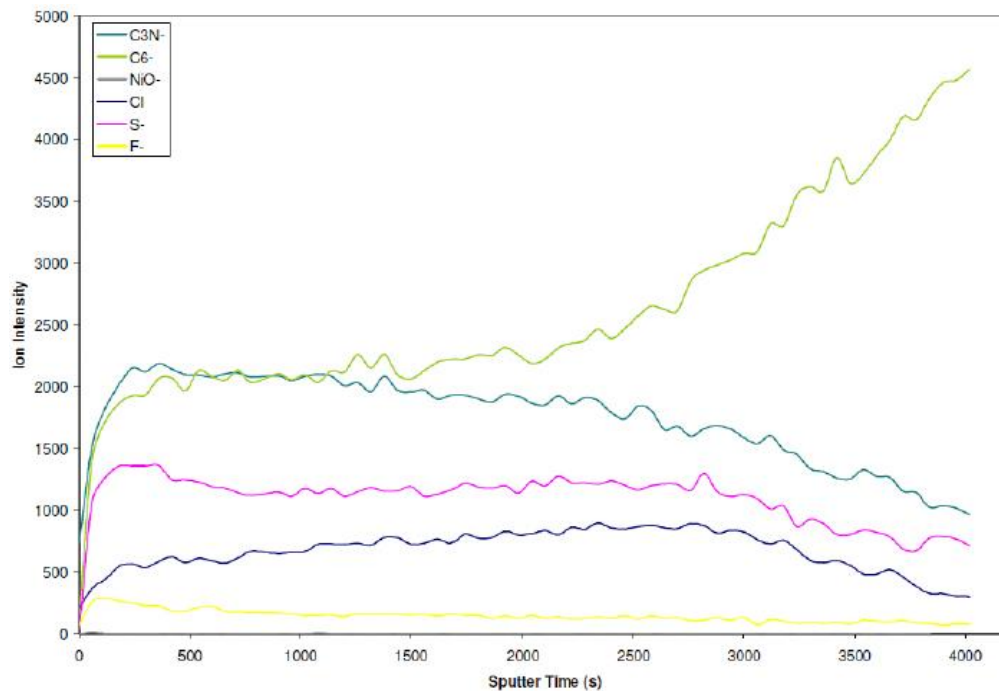


Injector Head
Deposit



Sputtering Time (Depth)

- Ability to observe changes in elemental ion presence with deposit depth.
- Establish what the primary constituents are and how they are layered.
- Infer information on formation dynamics.





- Fuel system deposit formations negatively affect engine performance and are not well characterised.
- ToF-SIMS can provide femtomolar mass sensitive (ppm) chemical analysis with depth through a surface.
- Deposits found to be complex layered mixture of carbon, polyaromatics, cycloalkanes, aromatics, straight chain and substituted alkanes, acids and inorganics.
- Better understanding of deposit formation is being used to develop strategies to prevent incidence.



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

Barker.J, Snape.C, Scurr.D.J, (2012) A Novel Technique for Investigating the Characteristics and History of Deposits Formed Within High Pressure Fuel Injection Equipment. SAE Int. J. Fuels Lubr. 5(3):2012

The Time-of-Flight Secondary Ion Mass Spectrometry documented here was performed in the Advanced Materials and Healthcare Technologies research group of the School of Pharmacy at the University of Nottingham.





- 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:

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