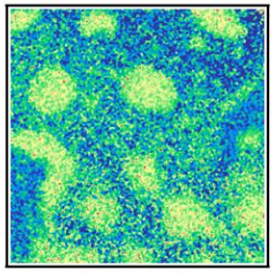
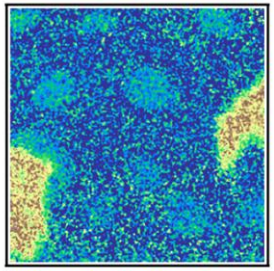
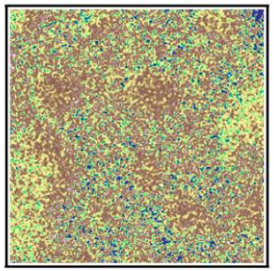
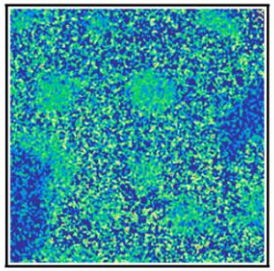
X-ray Photoelectron Spectroscopy (XPS)
Case Study:

Polymer Composition and Spatial Distribution


Fluorine at%


Oxygen at%


Carbon at%


Nitrogen at%

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Polymer Characterisation

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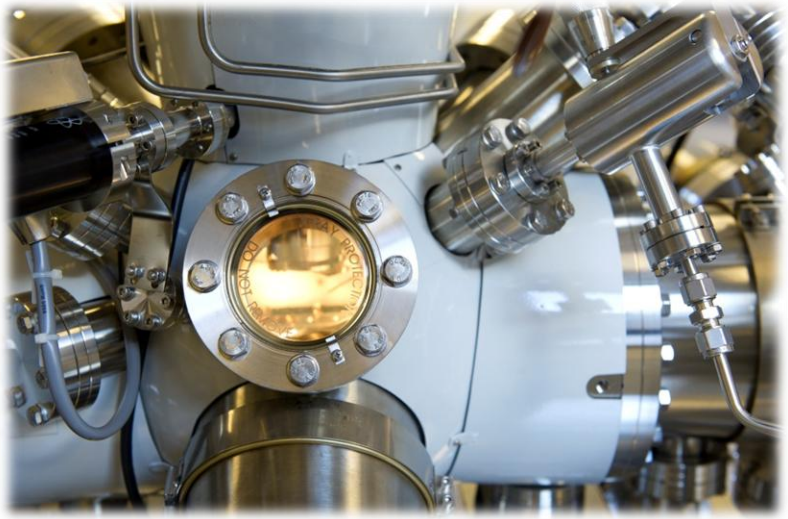
- Polymers are not always directly or easily identifiable at material surfaces.
- Macro distributions and thicknesses may be of interest.
- X-ray photoelectron spectroscopy (XPS) is sensitive to light elements.
- XPS is also a highly surface sensitive technique (~ top 10nm), ideal for studying thin films of polymers or liquids*.



** Analyse ionic liquids with the liquid phase photoelectron spectroscopy instrument (LiPPS) at the NNNC.*

XPS Principles

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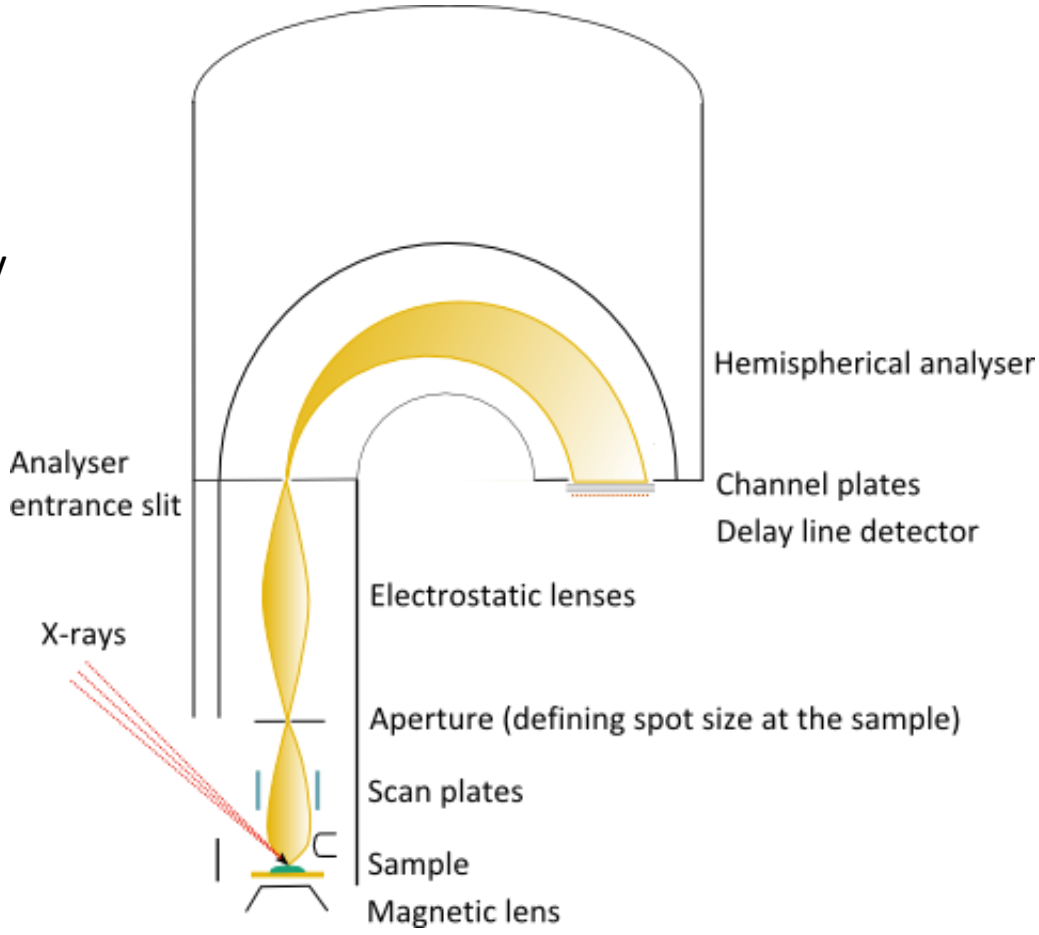
- X-rays excite electrons out of the sample surface.
- These are collected and their energy analysed.
- Electron energies depend on the element they originate from.
- The resulting spectrum is dependent on what elements are in the surface layer and in what abundance.



Spectral Identification

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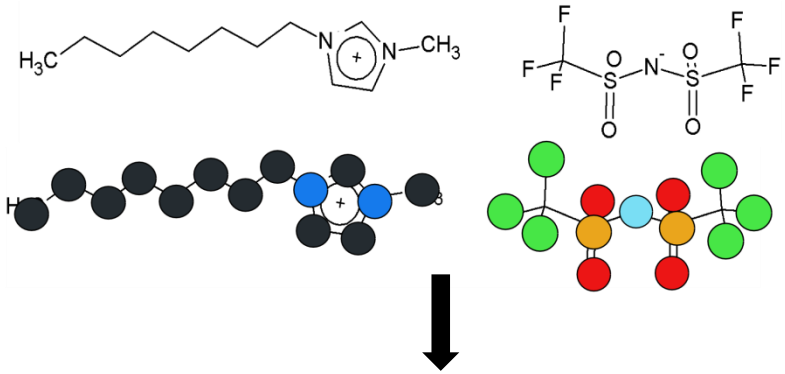
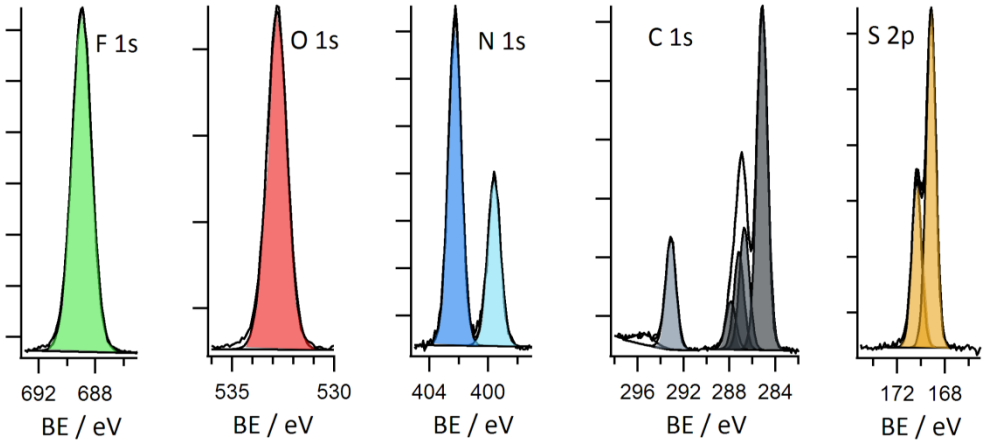
- XPS Identification of polymers possible by elemental spectra.
- Example analysis of an ionic liquid:





	Fluorine	Oxygen	Nitrogen	Carbon	Sulphur	Total
No atoms	6	4	3	14	2	29
at% expected	20.7	13.8	10.3	48.3	6.9	100

Spatial Localisation

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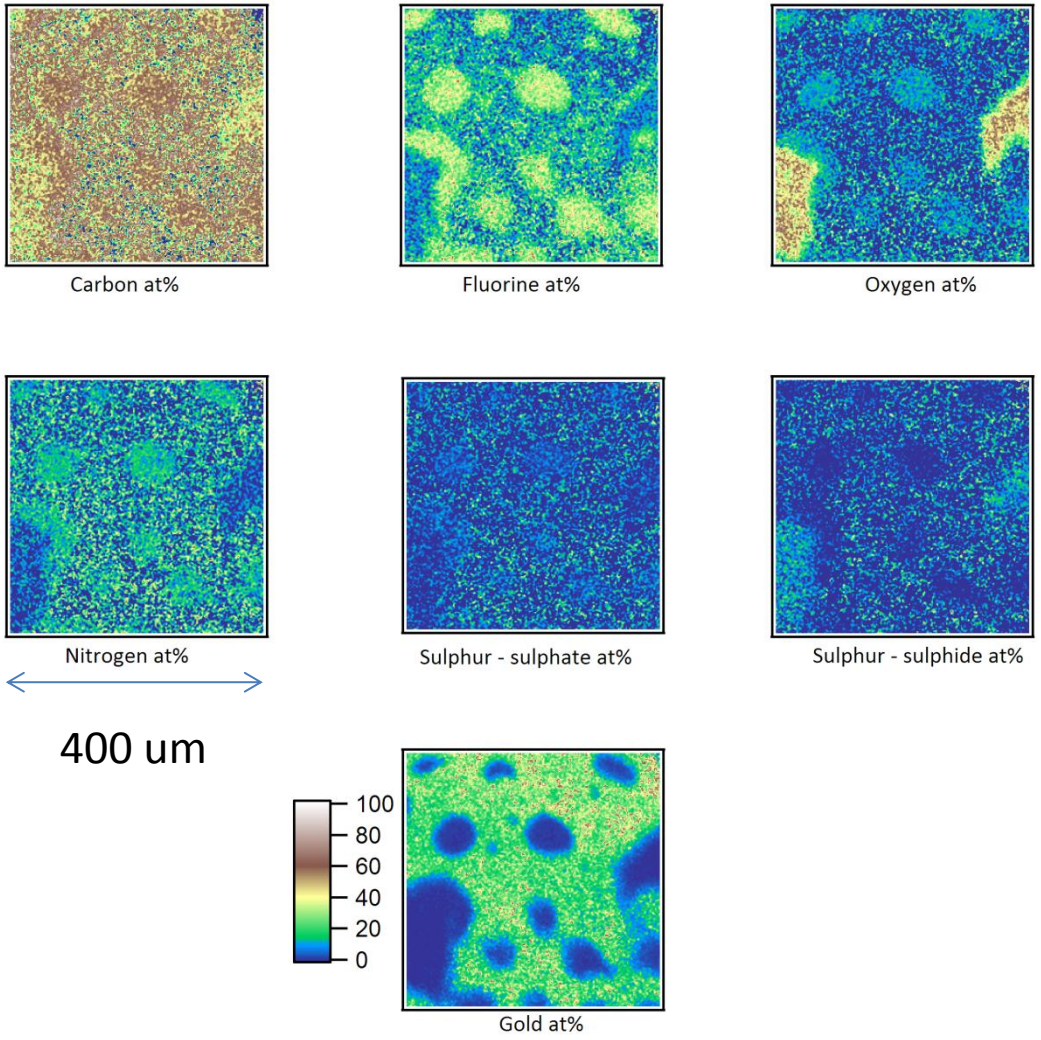
- Parallel imaging of a sample surface can be performed.
- This can provide spatial distribution of elements, and therefore surface components e.g. polymers
- Example XPS distribution of an ionic liquid droplet distribution on a gold surface.



Summary

Research Case Study

- XPS is a highly surface sensitive technique capable of chemical identification localisation, and quantification.
- Sensitive to light elements with ~0.1% atomic sensitivity it can play a key role in thin film polymer and liquid characterisation.
- Potential applications:
  - *Polymer identification.*
  - *Surface enrichments of one polymer constituent.*
  - *Drug entrapment and depth and coverage with protective layers.*
  - *Micron scale polymer spatial segregation or coating distributions.*
  - *Chemical stability of coatings.*
  - *Polymer mixing in cross section.*

Further Information

Research Case Study

For further information on how XPS, or the Nottingham Nanotechnology and Nanoscience Centre could help with your applications, systems and designs please contact:

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+44(0)781 645 3130

ISAC is a University of Nottingham Centre of Excellence in partnership with the National Physical Laboratory

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

E. F. Smith, D. Briggs, and N. Fairley, "Further developments in quantitative X-ray photoelectron spectromicroscopy: preliminary results from the study of germanium corrosion," *Surf. Interface Anal., vol. 38, no. 2, pp. 69–75, 2006*.

E. F. Smith, F. J. M. Rutten, I. J. Villar-Garcia, D. Briggs, and P. Licence, "Ionic Liquids in Vacuo: Analysis of Liquid Surfaces Using Ultra-High-Vacuum Techniques," *Langmuir, vol. 22, no. 22, pp. 9386–9392, Oct. 2006*.

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