X-ray Photoelectron Spectroscopy (XPS) Case Study:
Polymer Composition and Spatial Distribution

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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.
• 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:

<table>
<thead>
<tr>
<th></th>
<th>Fluorine</th>
<th>Oxygen</th>
<th>Nitrogen</th>
<th>Carbon</th>
<th>Sulphur</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No atoms</td>
<td>6</td>
<td>4</td>
<td>3</td>
<td>14</td>
<td>2</td>
<td>29</td>
</tr>
<tr>
<td>at% expected</td>
<td>20.7</td>
<td>13.8</td>
<td>10.3</td>
<td>48.3</td>
<td>6.9</td>
<td>100</td>
</tr>
</tbody>
</table>
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

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