X-ray Photoelectron Spectroscopy and Material Deposition

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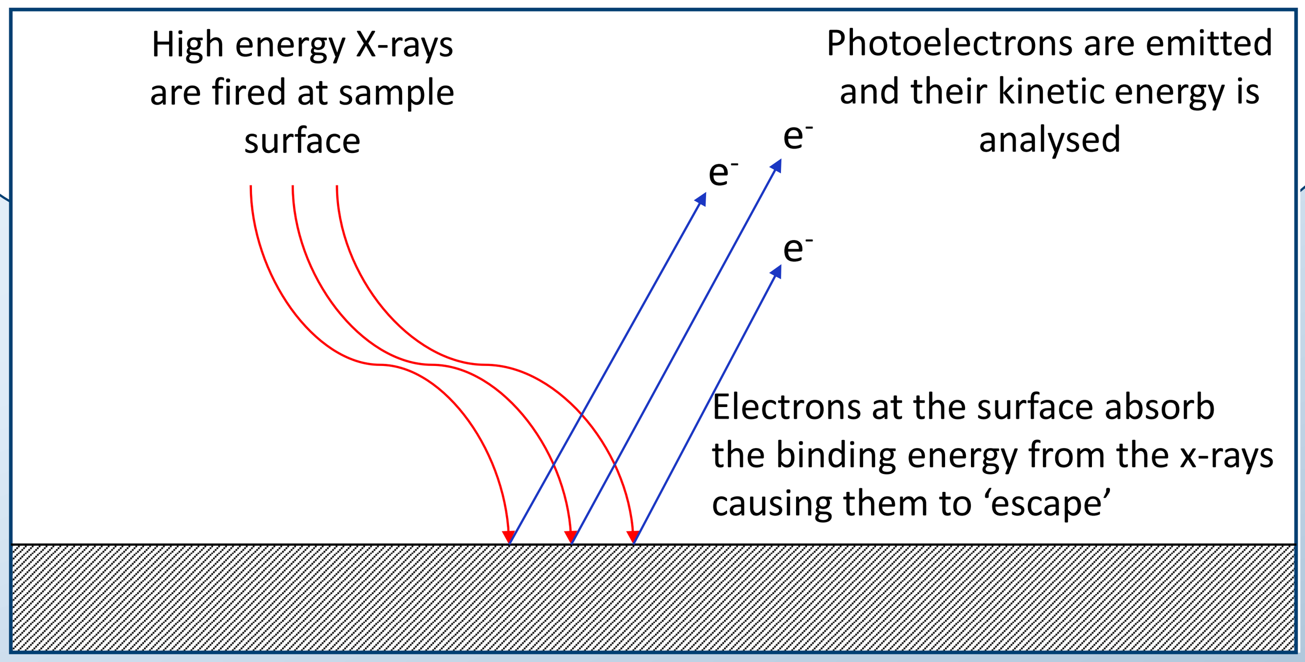
Background Information

X-ray Photoelectron Spectroscopy (or XPS) is a surface testing technique. XPS works by firing x-rays at the surface of a sample. These x-rays then supply energy to the surface electrons of the sample. Photoelectrons are then emitted if a sufficient amount of energy is supplied. The amount of electrons emitted from the sample surface and their kinetic energy is then measured. From this information the surface elements can then be identified.

Sputtering is a method in XPS of removing material from the surface of samples. Sputtering can be used to deposit material on sample surfaces, however the previous method only allows the deposition of one material per loaded sample. There are also very few methods of generating accurate samples of untested materials such electrically conductive inks.



Project Aims

There were two main aims of the project. Both were to investigate and develop various depositional techniques for X-ray photoelectron spectroscopy. The project aims were as follows:

1. **In-situ multi-sputter deposition -** The first project investigated multi-deposition techniques for the K-Alpha Spectrometer.
2. **Inkjet printers and sample creation -** The second project investigated the possible use of an inkjet printer for specialised sample production.

Left: Image showing JetLab 4 inkjet printer used for aim 2.

Image curtesy of M. Benning[1]

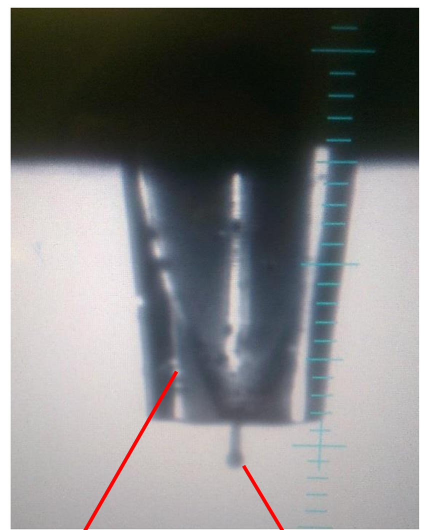
Investigation: Multi-Sputter Deposition

The modification for the K-Alpha Spectrometer has been developed for the 'tilt block' sample holder. Certain mechanics of the tilt block were found to be useful in the development of the modification.

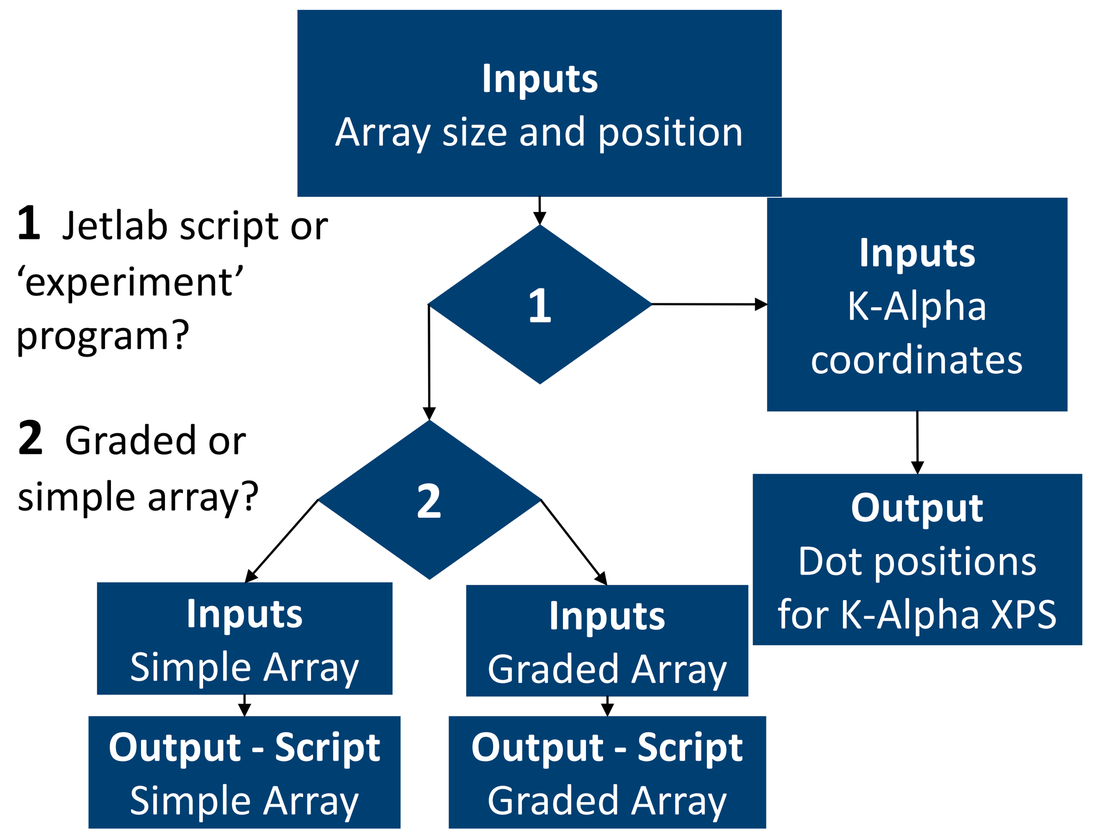
The design of the multi-sputter deposition tool uses a halved hexagonal material mount. This design optimises the maximum number of mounting faces whilst keeping within the tolerances of the sputtering ion beam. Hexagonal end caps hold the mount and thin materials such as metallic foils. The design also allows thicker polymer samples to be adhered to the surface of the hexagonal mount. Repeatable sputtering positions were also investigated by finding driven angles for each face.

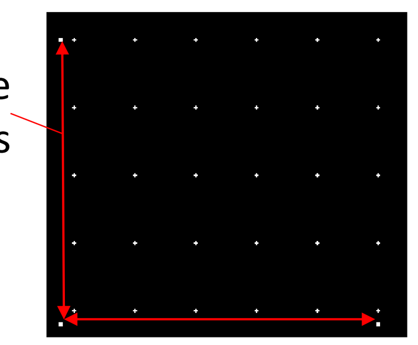
Right: Jetlab 4 maintenance camera showing droplet formation. Droplets can be approximately 80µm in diameter

Image (right) curtesy of M. Benning [1]

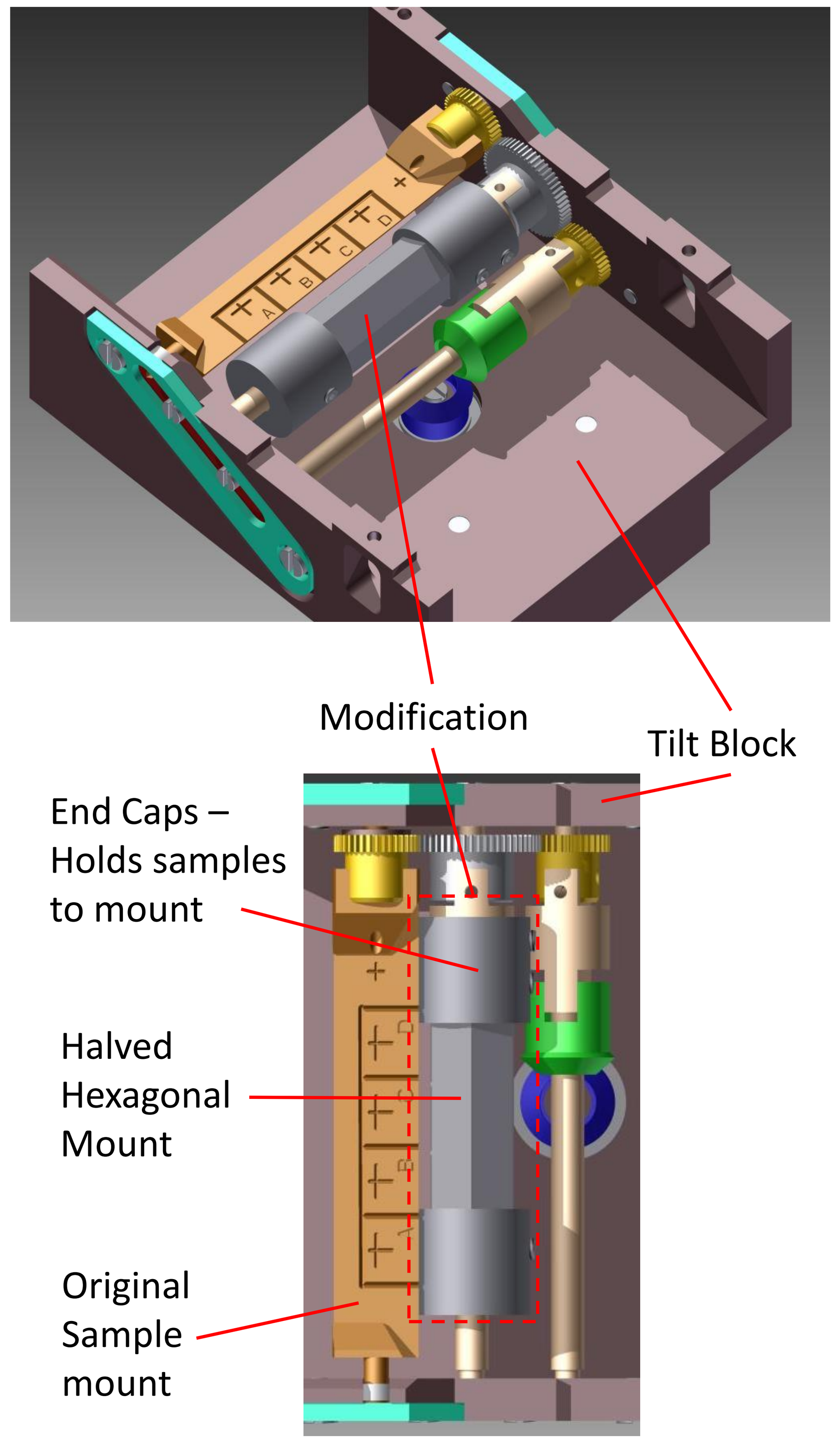


Below: Program map of Jetlab script and 'experiment' program





Left: Example map of a 6 by 5 array. Drop separation approx. 5mm



Investigation: Samples and Inkjet Printers

The Jetlab 4 inkjet printer was identified as a key candidate for specialised sample creation. The Jetlab 4 desktop inkjet printer has an incredibly high accuracy and repeatability. In addition, there is the capacity to print with conductive inks and polymers untested by the XPS team.

During the investigation, it was seen to be a very time consuming process to create samples with the Jetlab printer. The most time consuming activities include writing printer scripts (programs the printer uses to identify the printing pattern) and writing 'experiment' programs for the K-Alpha XPS machine. Therefore, a program was written to automate these time consuming processes.

Conclusions and Implemented Designs

The tilt block modification supports six mounted materials. A program identifying the driven angles for each face was also written. Three out of the six faces are theoretically the most repeatable positions. Due to the time frame of the investigation the actual repeatability of these positions could not be tested. Overall the first project led to the design and manufacture of a mechanically successful multi-sputter deposition tool. The investigation did not test the deposition repeatability, however this can easily be completed in the future.

Untested, but printable, materials are still under examination. The feasibility of the use of an inkjet printer has been successfully investigated. The program reducing experiment time will allow the XPS team to quickly produce printer scripts and K-Alpha 'experiment' programs. After hardware setup is completed, the scripts and programs can be easily imported into their respective machines to allow almost instantaneous production and experimentation.

Final Design of modification

References

1. Dr Matthew Benning, EPSRC Centre for Innovative Manufacturing in Medical Devices, Newcastle University, UK