Retrieval of the lost literature from the Herculaneum Papyri with the X-ray Fluorescence Microscopy

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The Herculaneum papyri in an ancient library buried by the eruption of Mount Vesuvius were recovered 260 years ago. The papyrus scrolls are highly carbonized during the volcano eruption and have become extremely fragile and disformed. The papyri appear to be black either in a full roll or in fragments. It is impossible to open them and read the text without damaging them irreparably. In order to read the content in the scrolls without unrolling them, The X-ray Phase Contrast Tomography was applied to reveal a ~~few~~ characters and few words from in-situ measurements [1]. In this work, we are using a different approach, the X-ray Fluorescence Microscopy (XFM) to study the intrinsic element contrast. The Synchrotron Radiation X-ray Fluorescence Microscopy (XFM) is an indispensable non-destructive method to study the material elemental information. High energy X-ray beam is used to excite the inner shell electron, leaving a vacancy in the atomic structure. To stabilize the atom, an outer shell electron will fill in the vacancy and emit an X-ray photon with a characteristic energy respectively to the element species. Therefore, by detecting energy and the intensity of the emitted X-ray photons, one can identify and quantify the elements in the materials.

The ink used to write in the papyri may contain Hg, Pb, or Fe, and the papyrus materials contain K and one can even identify the waiving pattern of the papyrus fibre[2]-[3]. An artificial sample of papyrus with multiple layers and with Greek letters written on it was scanned by XFM with the confocal setup. One managed to measure the 2D elemental maps and at multiple depths into the sample with 30μm depth resolution. Letters from individual layers can be clearly identified by the Pb maps. Then a few fragments of the Herculaneum papyri are scanned with confocal XFM identifying some letters within fragments containing multiple layers. The fragments are also scanned with X-ray Fluorescence Tomography for the technique comparison.

References

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