Report MD546: XRF and XANES experimental session

The lung tissue reaction to asbestos fibres is an issue at today that needs deep investigation not only for the understanding of physico-chemical properties that confer a specific toxicity to this material but also in order to prospect diagnostic and therapeutic interventions in the asbestos-related diseases [1]. The research greatly depends from the availability of high sensitive techniques that could allow assessing the distribution of the asbestos fibres in possibly untreated histological samples and that can help the understanding of the formation mechanisms of the asbestos bodies. These structures consist of asbestos fibres coated by iron containing proteins and other organic material and that are the histological hallmark of asbestos exposition. At present, we are performing series of experiments that combines different synchrotron techniques with the aim of revealing new biochemical traits of their presence.

In the present beamtime we performed XRF analyses with an incident energy of 7.3 or 7 keV on histological fixed tissues placed onto gold grids or on ultralene foils. The analyses demonstrate that the technique allows to reveal both asbestos bodies and free fibres in the tissue. For the first time we show an elemental mapping of these structures resolved at high spatial resolution and inside the tissue. Unique results were obtained by monitoring the Fe presence which allows to reveal also very thin fibres as shown in the figure 1. XRF analyses also show that other elements are involved in this tissue reaction and particularly Ca and P.

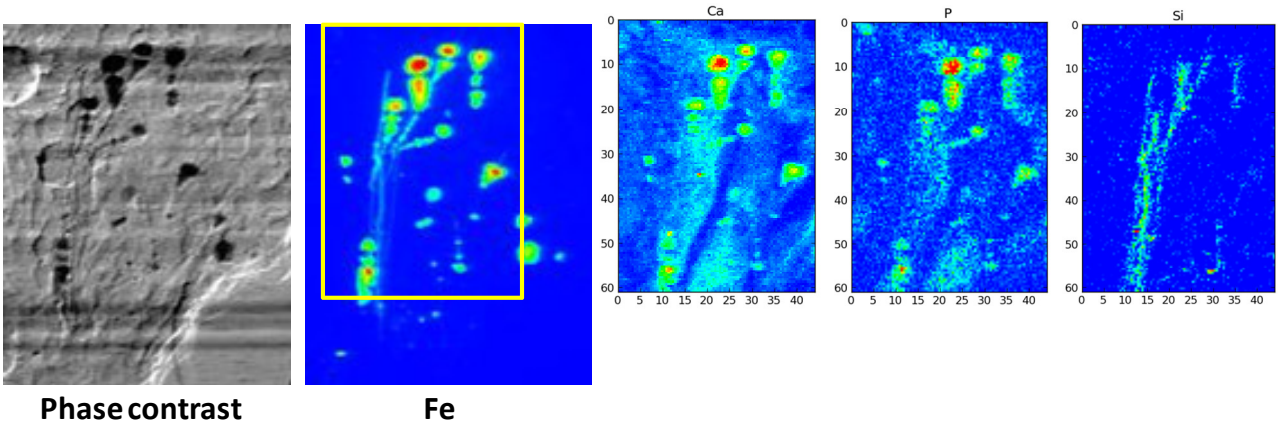

Figure 1. Free fibres and asbestos bodies are found. Free fibres where invisible under optical microscopy and lightly detected by phase contrast. Panels show the chemical composition.

The asbestos composition is clearly distinguishable from that of other pollutant particles in the lung tissue as shown in figure 2.

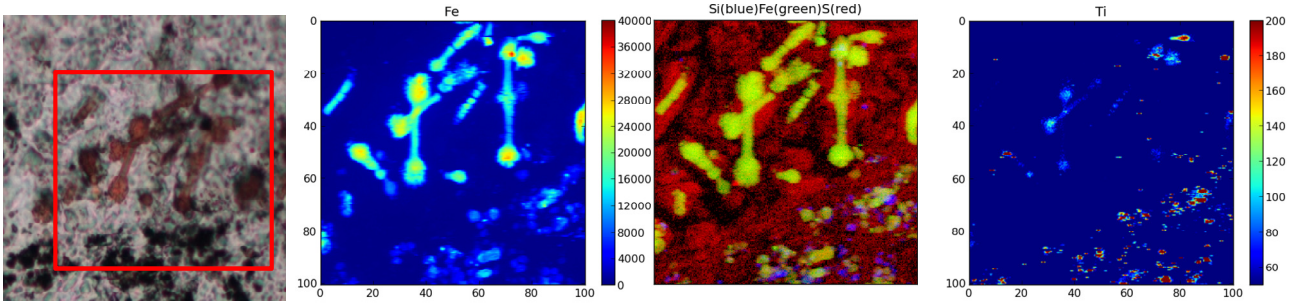

Figure 2. First panel is an optical image of the tissue section. XRF maps for Fe and Ti and Fe-Si co-localization are shown

Fe is not only a constituent of some asbestos types, but it is also the key element in the formation mechanisms of the asbestos bodies The high intensity of Fe and its signal spread in the asbestos surrounding area suggests a large mobilisation in the tissue of this elements as well as of the related molecular actors.

In order to understand the chemical nature of Fe in the process, XANES experiments were successfully performed. In figure 3 an example where single spot spectra are compared with a standard of ferritin.

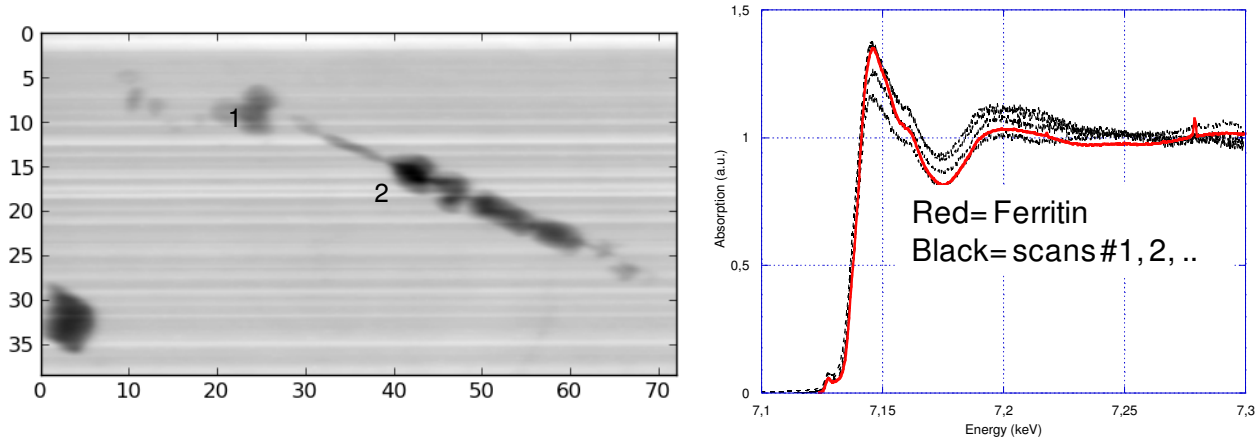

Figure3. An asbestos body in tissue section (phase contrast image) and XANES spectra collected on the coating. In red, ferritin standard.

The results need to be carefully analysed and repeated in order to confirm the presence of ferritin and of other chemical forms of iron in the asbestos coating and fibre.

All the results of this experimental session were successful showing for the first time the possibility of detecting asbestos fibres together with asbestos bodies by XRF. Novel information on the participation of Fe and other elements are expected, although a relation with fibre features (composition and shape) need to be further investigated by expanding the number of analyses.