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Negative muons for the characterization of thin layers in Cultural Heritage artefacts

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Muonic X-ray Emission Spectroscopy (μXES) is a novel technique based on the detection of high-energy X-rays emitted after the interaction of a negative muon beam with matter. Thanks to the multi-elemental range, a negligible self-absorption effect of the x-rays and very low residual activity left in the sample after irradiation, the technique has been applied to a wide range of studies, with special attention to cultural heritage artefacts. In addition, the technique offers the possibility to perform depth profile studies. By tuning the energy of the incident muon beam, indeed, it is possible to investigate the different layers that constitute a sample. Here we report preliminary results of the analysis on two fire-gilded surfaces, in which the gold layer was supposed to be around 10 microns. In particular, in this work, the technique is coupled with a Monte Carlo based simulation software. Simulations are a powerful tool for improving the data analysis and the interpretation: for μXES especially, by exploiting a simulation software like SRIM or GEANT4, it is possible to assess the thickness of a given layer. To perform a depth profile characterization, the samples were analysed at different beam energies (or momentum). Each of the resulting x-ray spectra was then analysed and gaussian fitted with a data analysis software. Then, the normalised area values were plotted against the momentum to obtain a profile of the variation of the elements as the penetration depth of the beam increased. The output of the simulations was compared with the experimental data and a remarkably good agreement was reached. The results of the work are promising and with this approach, it will be possible to enhance the capability offered by the technique both in terms of data analysis and data interpretation.

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