M2 Master training (février-juillet 2023)

Laboratoire des solides irradiés (LSI), Ecole polytechnique 91128 Palaiseau
Nadège Ollier, directrice de recherche
nadege.ollier@polytechnique.edu

Glass recycling and decoloration from Roman period: photoluminescence contribution

This intership deals with the Roman glass and in particular we want to finalize a new method that we developed based on photoluminescence, in order to classify the decolored glass. We will mainly work on glass samples coming from Reims.

Today, 87 secondary glass workshops dating from the 1st to 6th centuries AD have been identified throughout the country [1]. Reims is known to have been a major centre of glass production, with several glassmakers' workshops in operation throughout the Roman period, but particularly in the 3rd and 4th centuries AD. Glass produced in Reims furnaces is divided into two compositional groups: 1) glass obtained by mixing manganese-decoloured glass, antimony-decoulored glass and colored glasses (recycled glasses) and 2) colorless glass obtained from glass bleached by adding pure antimony. In short, whether obtained by recycling or by adding oxides, the majority of glasses produced in the late Reims workshops are decolored. It is very difficult to categorize such glasses with the naked eye.

In collaboration with Aurore Louis from Inrap, we will therefore aim to identify groups of colorless glasses by carrying out photoluminescence (PL) analyses in LSI. To this end, we will continue to optimize a method we have developed in 2023, based on the detection of $Sb^{3+,}$ Mn^{2+} and Fe^{3+} ions by PL and a semi-quantification of these species (Figure 1).
We will also focus on Pb^{2+} and Cu^{+} ions (potential indicators of recycled glass). To better understand and analyse the shape of the 400 nm band, containing Pb^{2+} and Sb^{3+} ions, which have similar emission properties, we will analyze soda-lime model glasses that will be synthetized in the laboratory.
In parallel, we will also look at recycling and its impact on glass coloring and chemical composition. We will be synthesizing and remelting glasses at LSI in collaboration with glassmakers. In particular, we will try to understand the impact of remelting cycles (duration, temperature, type of furnace) on iron and manganese redox and glass structure using various spectroscopic techniques (Raman, Electron Paramagnetic Resonance and PL).
The ultimate aim is to classify Roman glass into different groups and better understand the workings of the various workshops in Reims.

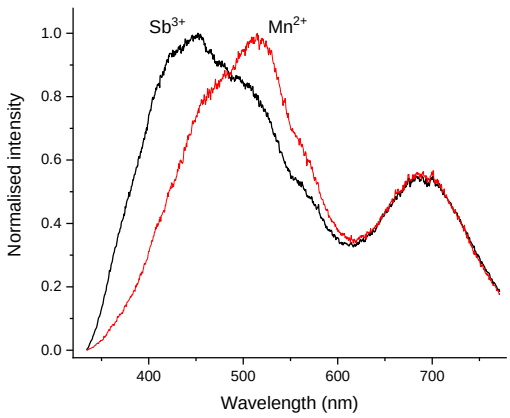

Figure 1 : Emission spectra of two glasses from Reims one is decolored with Sb (black spectrum), the other one (red one) is reclycled (mixing Sb and Mn).

The student should have a pronounced taste for interdisciplinary work.
Methods and techniques: Glass synthesis, photoluminescence, Electron Paramagnetic Resonance, Raman spectroscopy

References :

[1] Foy D, Nenna M-D (2001) Tout feu, tout sable:Mille ans de verre antique
dans le midi de la France. Musée d'Histoire de Marseille, Édisud, Aix-en-Provence