XEOL investigation of Rare Earth ions in luminescent silica-based nanoparticles.

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In this contribution an apparatus for the collection of X-ray Excited Optical Emission (XEOL) spectra is presented. This technique is applied to rare-earth based luminescent materials for medical applications. Good quality data can be collected and the spectra reveal different environments for the Rare Earth ions depending on the preparation route.

Introduction

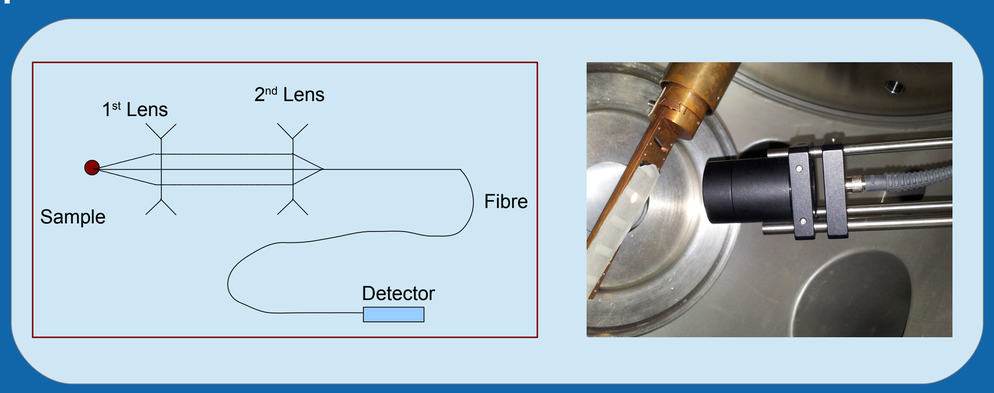
Optical imaging is the latest trend in imaging-guided diagnosis and/or therapy that involve the detection of light photons transmitted through tissues. The challenge is to prepare structures (namely **nanoparticles** (NP) doped with Rare Earths (RE) that can enter the human body) emitting light in a spectral range of minimum absorption by the tissues.

Sample preparation

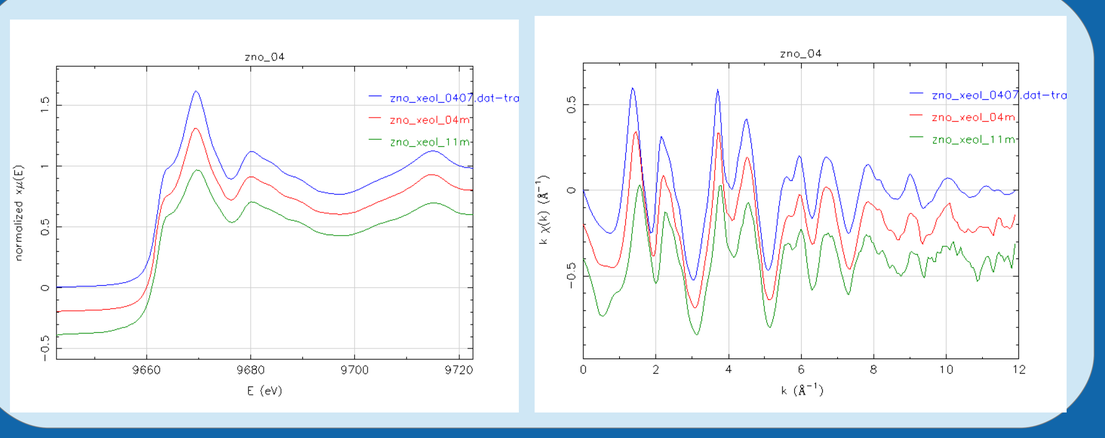
IST has addressed the problem of Er/Yb-doped-NP with **improved up-conversion efficiency** . Two kind of samples were compared here: I) RE doped (fluoride precursors) $NaYF_4$ NPs dispersed in silica (F-type) and II) RE-doped (acetate precursors) silica NPs (A-type).

The XEOL apparatus @ GILDA

XEOL data were collected at GILDA the Italian CRG at the European Synchrotron Radiation Facility. A **sketch of the apparatus** is shown below:



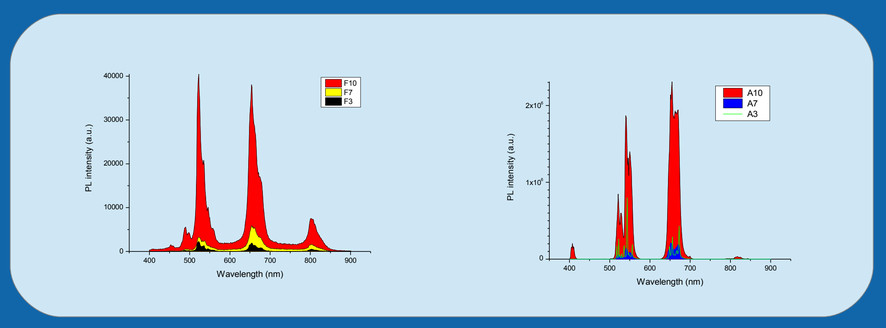
The light emitted by the sample is collected by two lenses and sent to the detector via an optic fibre. The detector consists in a Phtoto Multiplier Tube (PMT) with a photocathode sensitive in the region 300-650nm.



Results of the **benchmark test** of the apparatus on a ZnO sample. The data collected in transmission mode (blue) , PMT detector (red) and a Si PIN diode (green) detector are compared.

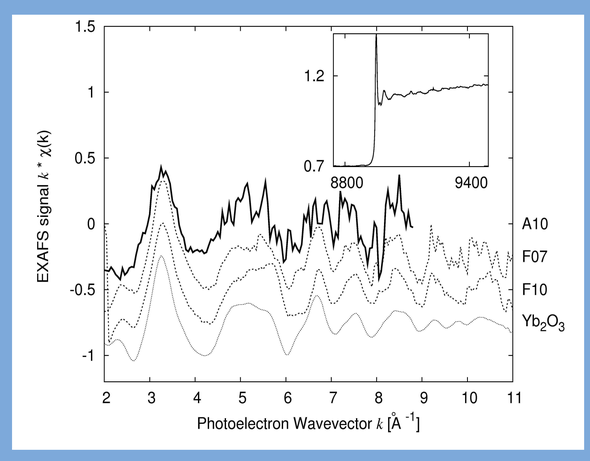
Optical characterization

The **Upconversion signal** from the samples was measured by exciting at 980nm. The picture below shows the emission patterns in the case of the F series (left) and A series (right).



XEOL data

In the present case the **XEOL** signal collected at the **Yb-L3 edge** is shown in the picture below:



The spectrum of the **A series** sample is typical of a **glassy** environment whereas that of the **F series** correspond to the **Yb oxyde**. Identical data are obtained my measuring XAS in the conventional fluorescence mode. The XEOL in this case is reasonably generated by the upconversion of Er ions neighboring (within about 100nm) the X-ray excited Yb ions.

Conclusion

A XEOL apparatus has been developed at the GILDA beamline at ESRF and is open to users. A test on rare earth doped nanoparticles has permitted to evidence a different environment depending on the preparation technique.

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