EUROPEAN SYNCHROTRON RADIATION FACILITY

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ESRF

Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office via the User Portal:

https://wwws.esrf.fr/misapps/SMISWebClient/protected/welcome.do

Reports supporting requests for additional beam time

Reports can be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title:** Rare earth dopant configurations in nitride phosphors for efficient LED lighting.	**Experiment number**: 26-01-946
Beamline: BM26A	**Date of experiment**: from: 15/06/2012 to: 18/06/2012	**Date of report**:
Shifts: 9	**Local contact(s)**: Sergey Nikitenko	*Received at ESRF:*

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Report:

During this beamtime we investigated europium doped $ZnGa_2S_4$. This phosphor material has been reported to be a saturated green phosphor, interesting for use in display technology. However the incorporation of the dopants is still a subject of debate. In literature it has been reported that the europium ions can:

1. Substitute for the zinc ions in the lattice,
2. Occupy tetrahedral interstitial sites in the lattice,
3. Substitute at octahedral voids in the lattice.

Another possibility is that the observed luminescence is originating from small amounts of $EuGa_2S_4$, which were formed unintentionally.

The EXAFS spectra collected during this beamtime at the Eu L_{III} edge and at the Zn K edge allowed us to study the incorporation of the dopant ions and to determine their position in the lattice.

First an analysis on the Eu L_{III} EXAFS spectra of $EuGa_2S_4$ was performed. The simulated data agree very well with the experimental data.

Next the XAS spectra, XANES and EXAFS, of the $ZnGa_2S_4$: Eu were analyzed. The XANES spectra at the Eu L_{III} edge show that the europium ions in $ZnGa_2S_4$ are present in a divalent valence state, which agrees well with the photoluminescence spectra.

Subsequently the EXAFS spectra at the Zn K edge and the Eu L_{III} edge were compared. Just by *fingerprinting* it is clear from the spectra displayed in Figure 1, that the europium ions do not substitute for the Zn ions in the lattice. However by comparing the EXAFS spectra at the Eu L_{III} edge of $ZnGa_2S_4$:Eu and of $EuGa_2S_4$, it is clear that the dopant ions are more likely to be present as small fractions of unintentionally formed $EuGa_2S_4$.

We performed the analysis on the doped samples, using the parameters obtained from the analysis of $EuGa_2S_4$. A nice results was obtained, but by looking closely to the radial distribution function we observed:

1. The intensity of the peak attributed to the nearest neighbors is too low.
2. The intensity of the peak attributed to the next europium neighbors is too high.

For this reason we investigated the other incorporation possibilities. If the europium ions occupy the octahedral voids in the lattice, their number of nearest neighbors increases and secondly there are no europium ions so the peak intensity should decrease.

We performed again an analysis on the europium doped samples, now including the possibility that part of the europium ions are incorporated in the lattice of $ZnGa_2S_4$ (Figure 2). This analysis allowed us to conclude that approximately 88% of the europium ions are present as unintentionally grown $EuGa_2S_4$ and only 12% of the dopant ions is incorporated in the lattice.

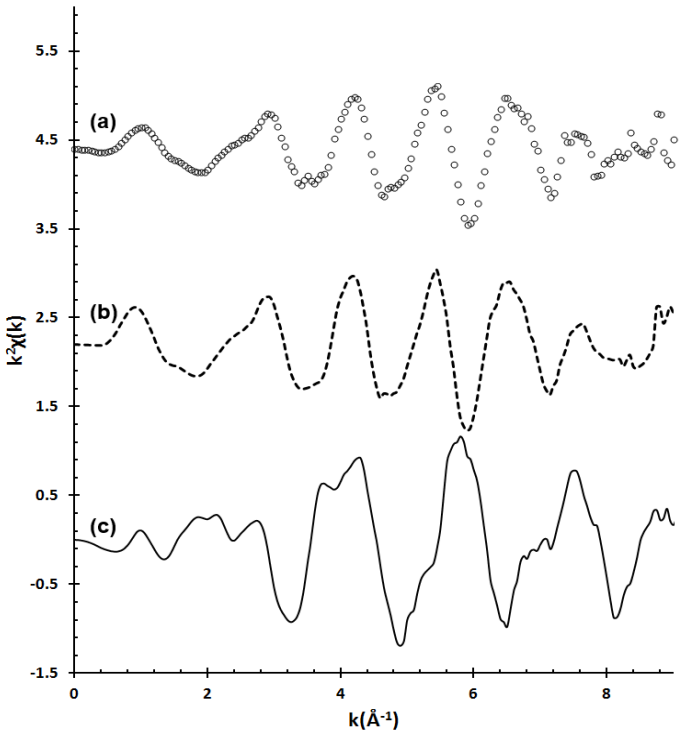

Figure 1: (a) Eu L_{III} edge extracted EXAFS spectra of $EuGa_2S_4$, (b) Eu L_{III} edge extracted EXAFS spectra of $ZnGa_2S_4$:Eu and (c) Zn K edge extracted EXAFS spectra of $ZnGa_2S_4$:Eu.

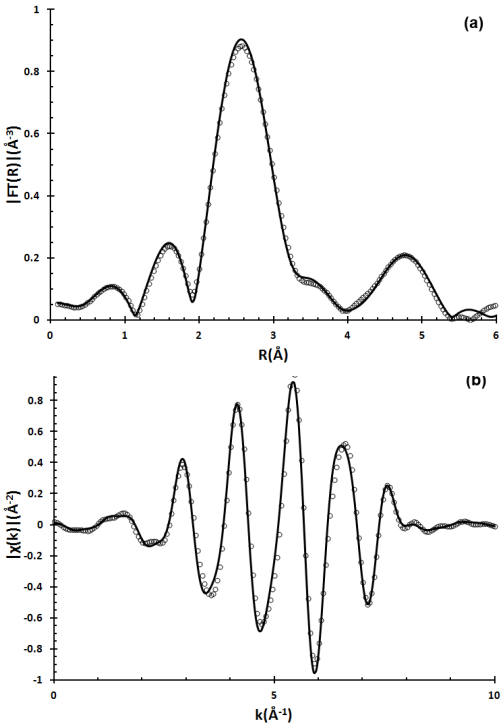

Figure 2: (a) Fourier transform of experimental (solid line) and simulated (circles) of Eu L_{III} edge extracted EXAFS spectra of $ZnGa_2S_4$:Eu (b) Back transformation of the data in (a) to k-space.

Several results of this campaign will be presented at the IWASOM13 conference, Gdansk, Poland.