ESRF	**Experiment title:** Determination of the structure of the luminescent erbium centres in single crystal silicon grown by Liquid Phase Epitaxy.	**Experiment number:** HS-230
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Report:

Aims

The experiment was devoted to the study of the local structure of Er in a silicon epilayer grown0 by Liquid Phase Epitaxy (LPE) and to the comparison of this structure to that exhibited by samples ion implanted with erbium and oxygen. The main feedback expected was to get informations useful for the improvement of the LPE process.

Experimental conditions

All the samples were examined under the same experimental conditions (room temperature, rotary pump vacuum -about 10^{-4} mbar).

As the samples consisted of thin (from 2 to 6 μm thick epilayers on a 600 μm thick silicon substrate, the EXAFS spectra were collected using the fluorescence signal of Er at 6.9 keV, due to the ionization of the L_{III} level at 8358 eV. The incident photon energy was varied between 8200 and 9000 eV, where the incremental increase in energy dE was taken so small to ensure an increment in dk systematically lower than 0.05 A^{-1}.

A 7-photodiodes matrix of hyperpure germanium, cooled at 77 K, was used as X-ray detector.

The integration times were varied between 30 and 40 s, and the total acquisition time was therefore ranging within 3 and 4 and half hours.

The line beam was mantained in the hybrid mode all over the duration of our experiments.

Characteristics of the samples examined.

All the samples consisted of Er-Si-In epilayers grown by LPE on (100) silicon substrates, both Float zone (oxygen poor) and Czochralski (oxygen rich). As reference, samples

implanted with erbium and erbium and oxygen were used, toghether with an erbium silicide ($ErSi_{1.7}$) and an erbium sesquioxide sample.

Experimental results and discussion

With the exception of two samples the absolute signal intensities and the signal to noise ratios are quite satisfactory and therefore the EXAFS spectra were suitable for subsequent Fourier transform analysis.

A qualitative examination of the spectra shows that all samples present the features of the erbium silicide reference sample, with the exception of the sample 2042 RTA which was heat treated after the growth and the Ion Implanted sample Sob4.
In the case of the Sob4 sample, infact, the Fourier transform module shows the features of the erbium oxide superimposed to those of the erbium silicide, while the EXAFS spectrum of the 2042 RTA sample presents the typical features of the erbium oxide.

These results are particularly interesting when compared to the corresponding results of Photoluminescence (PL) measurements, which showed that the PL of the samples presenting Er in a silicide environment, when present, is significantly less intense than that exhibited by samples in a oxide environment
This conclusion is well in agreement with literature reports on this subject, which infact call for enhanced luminescence of Er, when it sits in a oxide environment.

Conclusions

The results of these experiments show that samples prepared using the LPE technique present almost the same properties of samples prepared by Ion implantation. Therefore, it seems already demonstrated that LPE is an alternative process for the preparation of Er-doped silicon epilayers.
It has been also proven that the CZ silicon substrate works as a source of oxygen, which diffuses into the silicon epilayer both during the LPE growth or during subsequent thermal annealing s .