Center for Optical Technologies

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Site Selective Spectroscopy of Er-ions in SiO_2/SRO films

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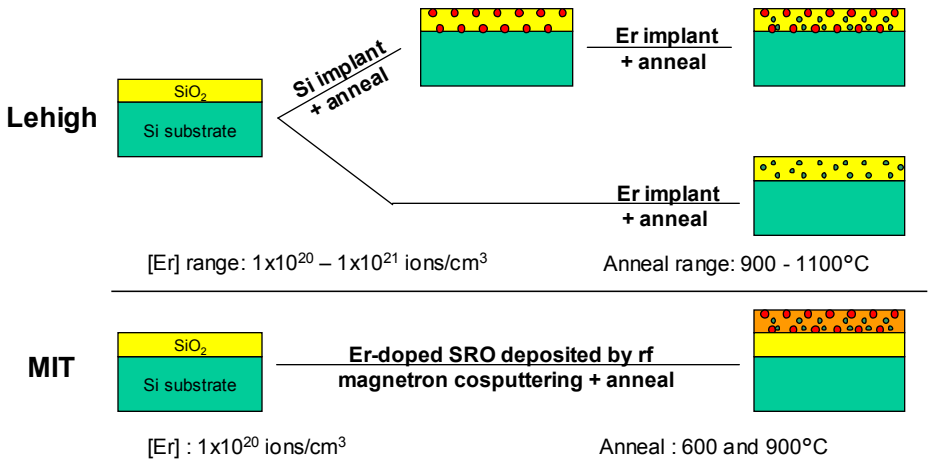
Goal: To gain a better understanding of how the Er defect behaves in the SiO_2/SRO environment in the hopes of implementing and optimizing electroluminescent silicon-based light-emitters.

Overview

Using the site-selective technique of combined excitation emission spectroscopy, we have studied a variety of Er doped silicon oxide layers and silicon-rich oxide (SRO) layers which contain silicon nanocrystals. With this technique we identified Er cluster defect sites which are created during thermal annealing and which dominate at high Er concentrations. We were also able to observe fluorescence line narrowing under resonant excitation allowing defect-selective excitation.

Sample Preparation

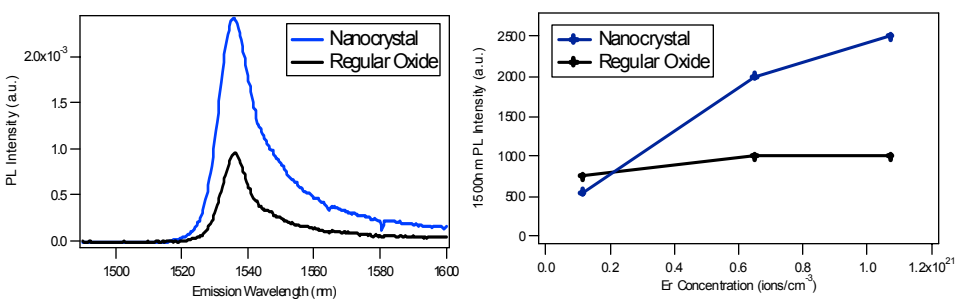


Experimental Technique

Combined Excitation-Emission Spectroscopy: Record a large number of emission spectra for a dense sequence of excitation energies

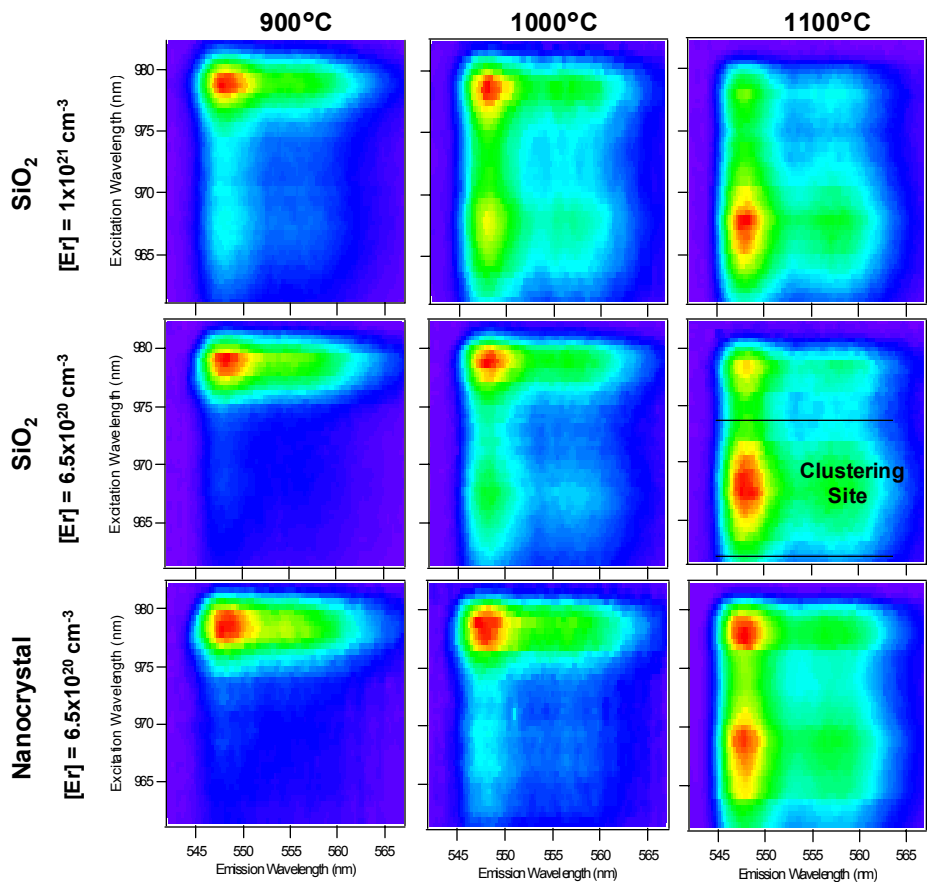
Comparing PL of SiO_2 and SRO

488nm excitation



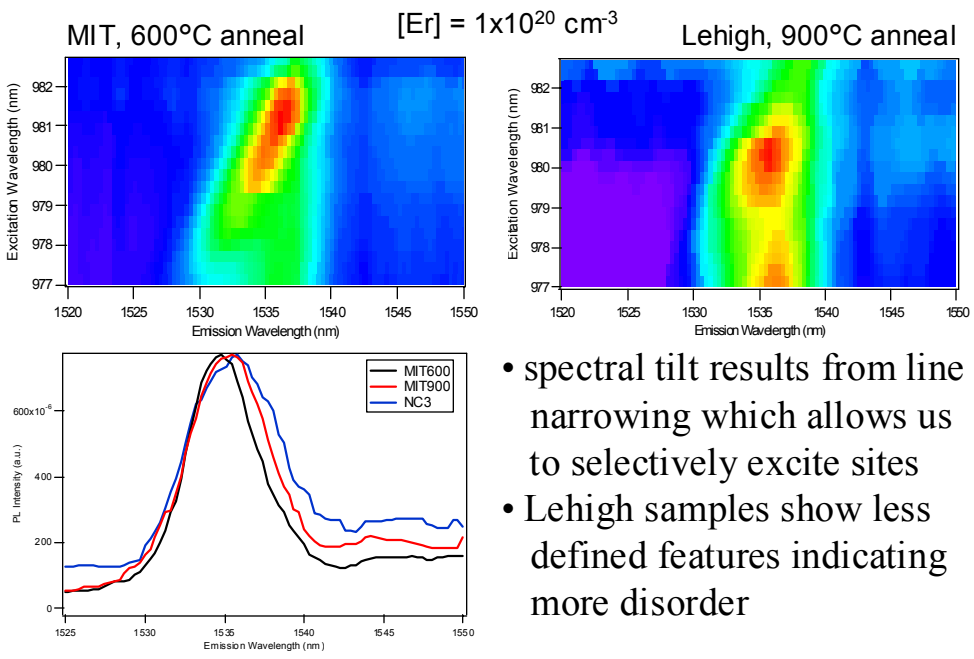
- Er emission from SRO is small at low Er concentrations indicating nanocrystals actually hinder emission here
- As Er concentration increases, the SRO sample produces much stronger emission than the regular oxide

Identifying Er Clustering Sites



- Clustering site increases with increasing anneal temperature
- In SiO_2 this is the dominant site after 1100°C anneal
- SRO samples show a reduced clustering effect which may result from nanocrystals increasing the solubility of Er ions by supplying more suitable sites or by attracting the ions

Selective Excitation of NC-related Er



- spectral tilt results from line narrowing which allows us to selectively excite sites
- Lehigh samples show less defined features indicating more disorder
- Fluorescence Line Narrowing (FLN) effect decreases with increasing anneal temperature and growth conditions

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