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On the interplay between Si-Er-O segregation and Erbium silicate ($Er_2Si_2O_7$) formation in Er-doped SiO_X thin films

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Abstract

Er-doped silica or rich-silicon oxide has been widely studied as 1.54 μm emitters. The incorporation of Si-nanoclusters is known for improving luminescence yield of Er^{3+} ions through an efficient sensitization of the neighbouring rare earth ions. The aim of this work is to investigate the influence of Silicon excess and Erbium concentration on the formation of silicon nanoclusters and Er-rich phase responsible of the quenching of 1.54 μm emission. Atom probe tomography and photoluminescence spectroscopy were used to explore the nanostructure and optical activity of Er-doped silicon rich silica. We present a direct evidence that both silicon excess and Er concentration influence the growth of Si nanoclusters, the formation of Er-Si-O phase and the luminescence of both Si nanoclusters and Er^{3+} ions. We explain these finding in relation with the growth mechanism of nanoparticles and the presence of a Snowman-like Janus morphology between silicon and Erbium silicates nanoparticles. In this contribution, we deciphered the nanoscale structure spatial correlations between Er and Si atoms in Er doped SiO_X which remained unclear for a long time.

Keywords: nanostructured materials, oxide materials, rare earth alloys and compounds, semiconductors, atomic scale structure, optical properties, luminescence, atom probe tomography

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