Erbium environment in glass-ceramics investigated by atom probe tomography

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ERBIUM ENVIRONMENT IN GLASS-CERAMICS INVESTIGATED BY ATOM PROBE TOMOGRAPHY

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Highlights

- partition of Er^{3+} ions in phase-separated nanoparticles smaller than 10 nm demonstrated with APT
- elucidation on the Er^{3+} ions nearest neighbors
- discussion between Er^{3+} ions local environment and macroscopic luminescent properties

Abstract

Glass-ceramics (considered here as a glassy host containing crystalline or amorphous nanoparticles) are of interest for luminescent properties as they can combine the sturdiness and low cost of a matrix host with particular spectroscopic behavior that would not appear in this host [1]. Ideally, nanoparticles would fully encapsulate luminescent ions to produce engineered spectroscopic properties. This approach is particularly promising for optical fibers. Indeed, silica is the most common glass used to prepare such waveguides. However, it is necessary to overcome some of its characteristics (high phonon energy, low luminesent ions solubility, …) which may be detrimental to luminescent properties.
As silicate systems have a large phase immiscibility domain when they contain divalent metal oxides (such as Mg), one can take advantage of thermal treatments inherent to the MCVD (Modified Chemical Vapor Deposition) process to obtain nanoparticles through phase separation [2]. By modifying Mg concentration, we have observed modifications of luminescent properties of Er^{3+} ions [3]. However the question arises of the partition of rare-earth ions in nanoparticles.
Qualitative partition of erbium ions in nanoparticles was reported thanks to Secondary Ion Mass Spectrometry analyses [4]. However, the spatial resolution is about the particle size. To go further, we take advantages of r ecent developments in Atom Probe Tomography (APT) which allowed the extension of such studies to glass-ceramics [5]. Partition of erbium ions is clearly observed in nanoparticles smaller than 10 nm (Figure 1). During this presentation, we will discuss this partition and the most probable nearest neighbors and correlate these results with luminescent properties.

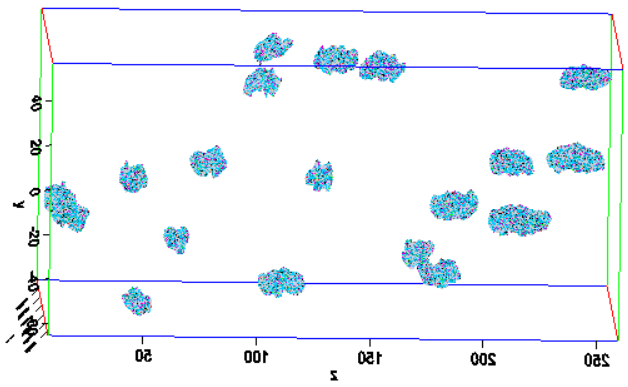

Figure 1. APT reconstructed volumes. Only Erbium ions are represented (in red). (Blue = isosurface ?)

References

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