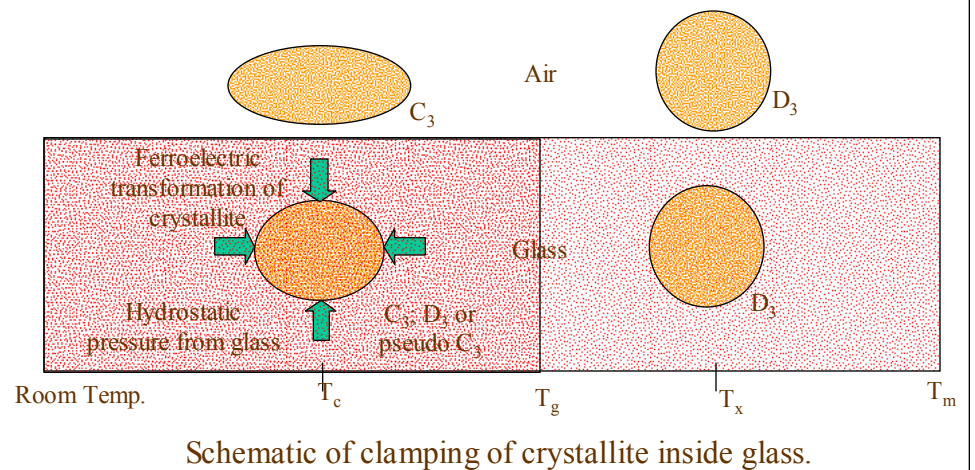


LaBGeO₅- A model transparent glass-ceramic for nonlinear optical applications

P. Gupta*, P. Capek, V. Dierolf, H. Jain

Introduction

The ferroelectric glass-ceramics (TFGC) contain ferroelectric crystallites, responsible for the high nonlinear optical activity of the overall material. The ferroelectricity of the crystallites can be suppressed due to clamping by the surrounding glass matrix, if the glass transition temperature (T_g) is higher than the curie temperature (T_c) of crystallites. We have investigated the ferroelectricity of the confined crystallites using optical methods. LaBGeO₅ is a model system for understanding this key problem because it is one of the few materials which congruently and homogeneously crystallize to become ferroelectric and also form glass easily.



In-situ Raman scattering studies of LaBGeO₅

Hypothesis: The freely grown crystal and clamped crystal have the following structural differences,

	Free crystal	Clamped crystal
Above T_c	Paraelectric, D_3	Paraelectric, D_3
Below T_c	Ferroelectric, C_3	C_3 ; D_3 or Pseudo ferroelectric

- The pseudo-ferroelectric phase has lattice parameter different from free crystal.
- 24 Raman-active A-modes in C_3 split into 10 A_1 Raman active modes and 14 A_2 Raman inactive modes in D_3 .
- The absence of peaks corresponding to A_2 modes will be indicative of clamping.

Results: Raman scattering has been performed on crystallite inside and on the surface (free crystallite) and on glass-matrix using unpolarized light. The spectra do not match with any of the published single crystal polarized Raman spectra [1].

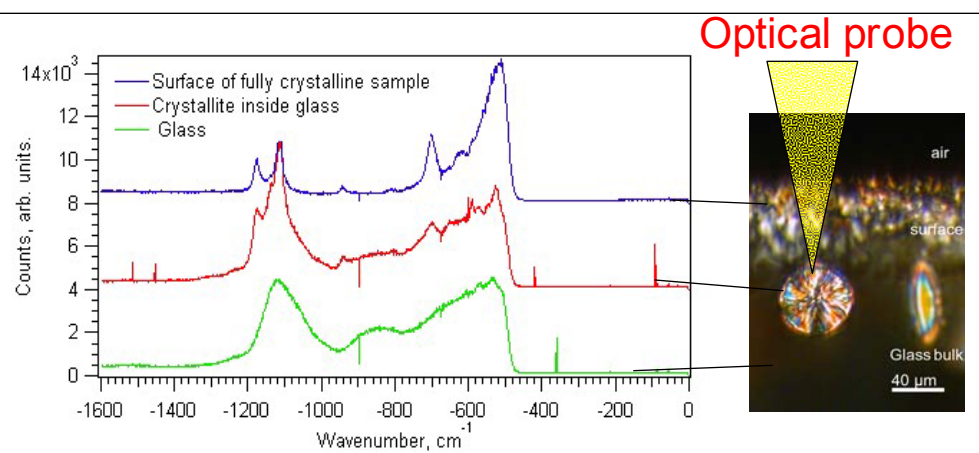


Fig. Unpolarized Raman spectra from a sample's surface, a crystallite inside the glass and the glass-matrix.

Conclusion: Preliminary results demonstrate the viability of the technique to obtain Raman spectrum from crystallites inside the glass-matrix. Further experiments on a crystallite with known orientation using polarized light will be performed to compare results reported in literature.

[1] I. Hruby, S. Kamba, J. Petzelt, I. Gregora, Z. Zikmund, Ivannikov, G. Komandin, A. Volkov, and B. Strukov, phys. stat. sol. (b) 214, 423 (1999).

In-situ photoluminescence from Er_{0.1}La_{0.9}BGeO₅

Hypothesis: La³⁺ is nine-coordinated (LaO₉) in LaBGeO₅ below T_c and ten-coordinated (LaO₁₀) above T_c (paraelectric phase). A small quantity of the La³⁺ is replaced by the Er³⁺. Since Er³⁺ goes into La³⁺ sites and emission of the Er³⁺ depends upon its coordination environment, we can deduce the state of the crystallites from difference in the emission spectrum.

Results: Preliminary result on a crystallites inside the glass-matrix are shown. Excitation with 980 nm laser produces green emission at 532 nm due to two-step up-conversion. The green emission intensity in crystallites is much higher than the glass.

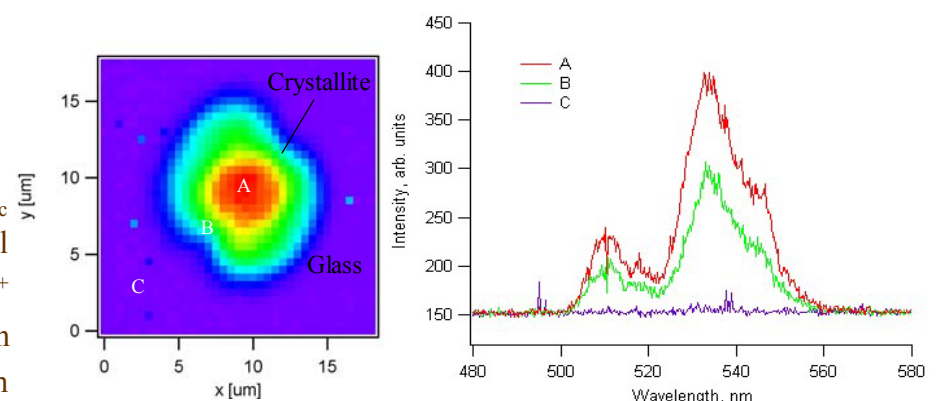


Fig: Emission spectrum from Glass-matrix and a crystallite inside glass.

Conclusion: The high intensity from the crystallites make it much easier to find and characterize the crystallites. The difference in the emission spectrum due to change in the Er³⁺ coordination will require performing experiment at low temperatures.