Multicomponent PAL model in application to Eu-doped $BaGa_2O_4$ ceramics

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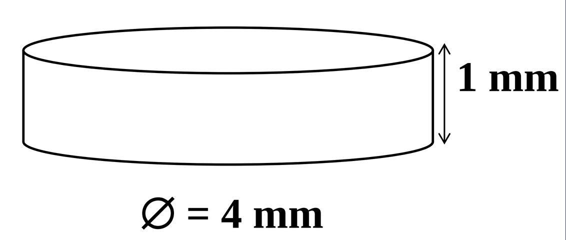
Introduction

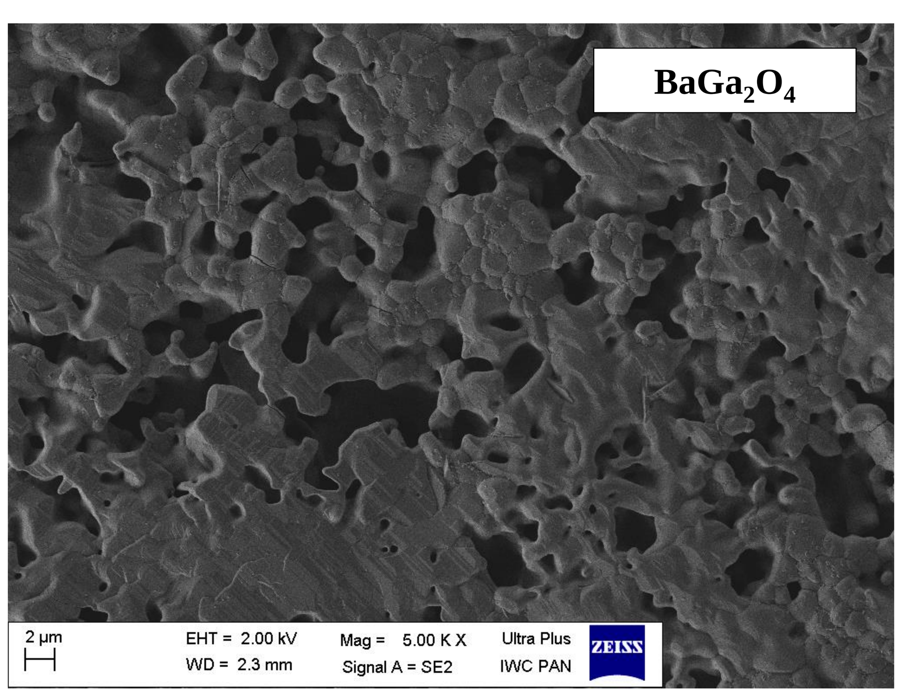
Polycrystalline $BaGa_2O_4$ ceramics are promising materials for different applications in part, as insulator materials in various optoelectronic devices, as a potential candidate for secondary electron emission coatings in plasma display panels, for proton ceramic fuel cells, etc. Doping of this materials by rare-earth ions results in the transformation of their luminescent and structural properties. The aim of this work is synthesis and study of structural properties of un-doped and doped with Eu^{3+} ions $BaGa_2O_4$ ceramics.

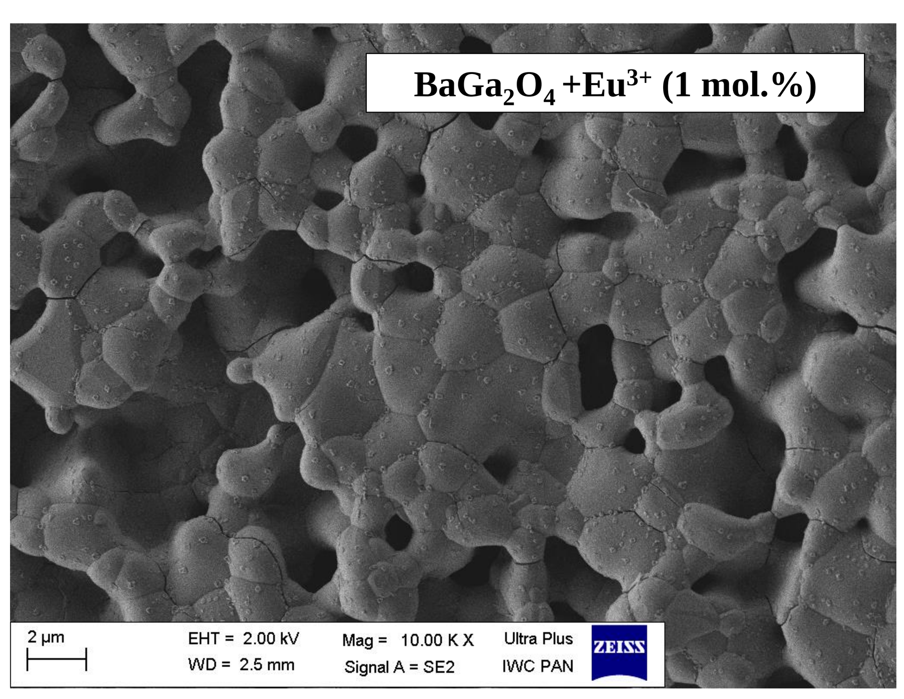
SAMPLE PREPARATION

The polycrystalline $BaGa_2O_4$ samples were prepared by solid-state reaction method. As starting materials $BaCO_3$ and Ga_2O_3 with purity 99.99% were used. Powders of stoichiometric composition with 0, 1, 3 and 4 mol.% of Eu_2O_3 (99.99%) were mixed in an agate mortar for 6 h with further pressing in a steel mold. Obtained pellets were annealed at 1200 ºC for 12 h in air. After that, the annealing of ceramic samples was carried out at 1300 ºC for 4h. The obtained polycrystalline ceramic samples were 4 mm in diameter and 1 mm in thickness.



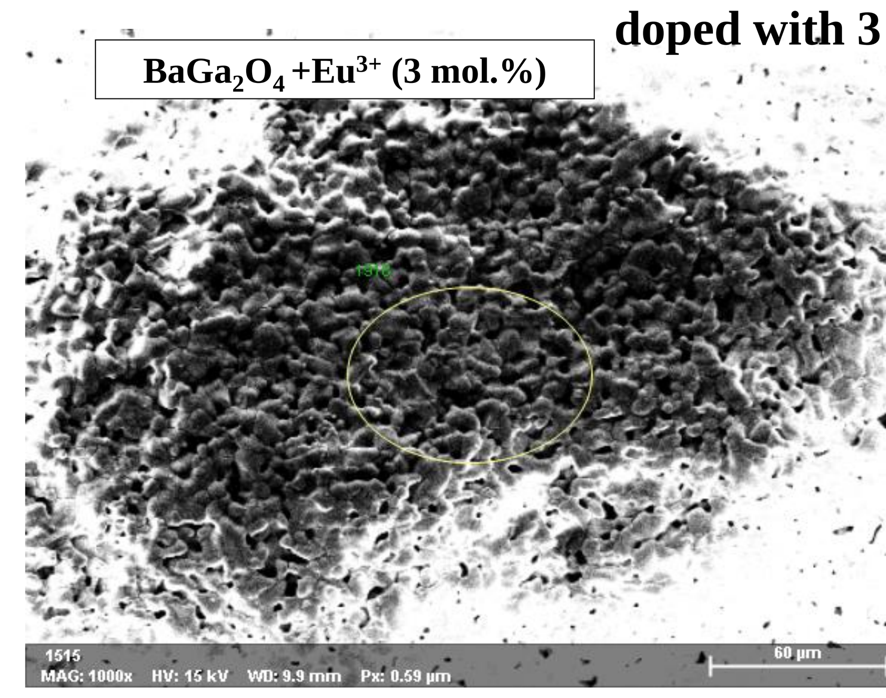
MICROSTRUCTURE OF CERAMICS

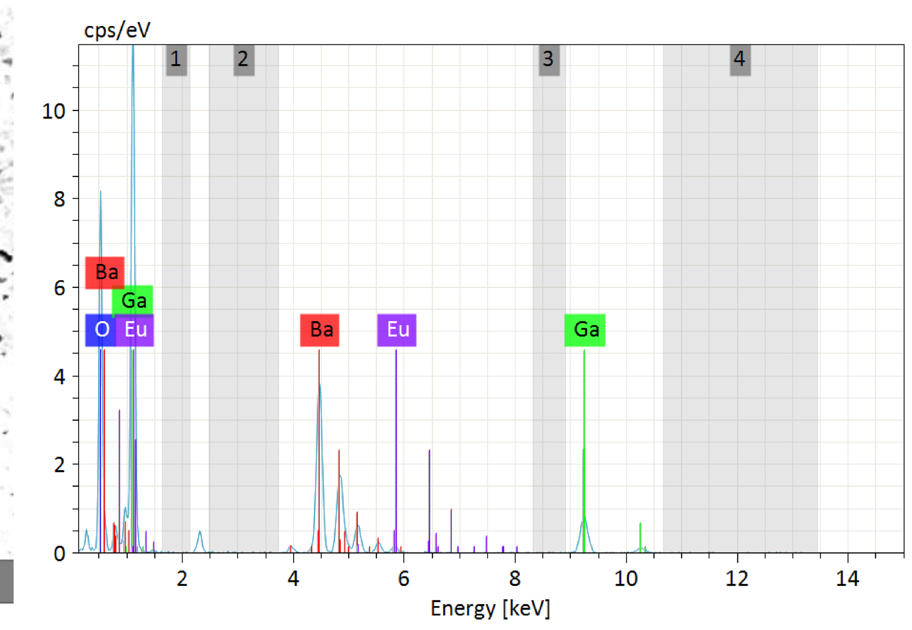




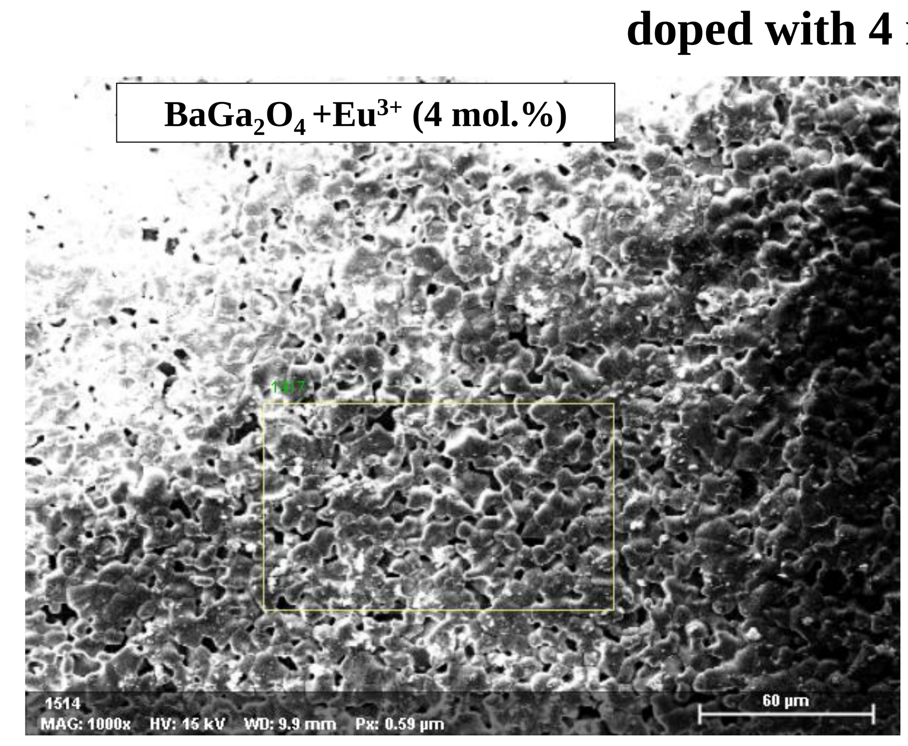
SEM and EDX results

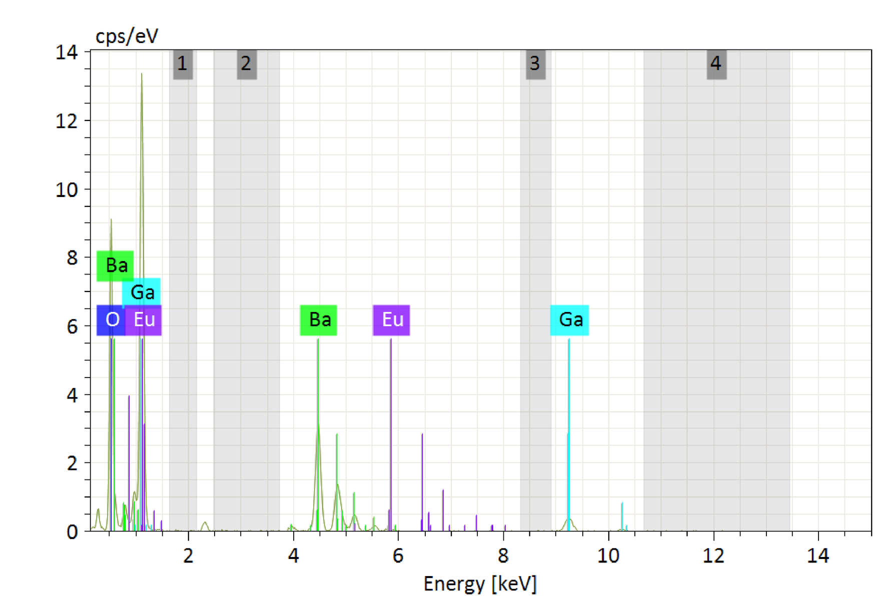
Microstructure of the selected area and elemental composition of $BaGa_2O_4$ ceramics doped with 3 mol% Eu^{3+} ions.



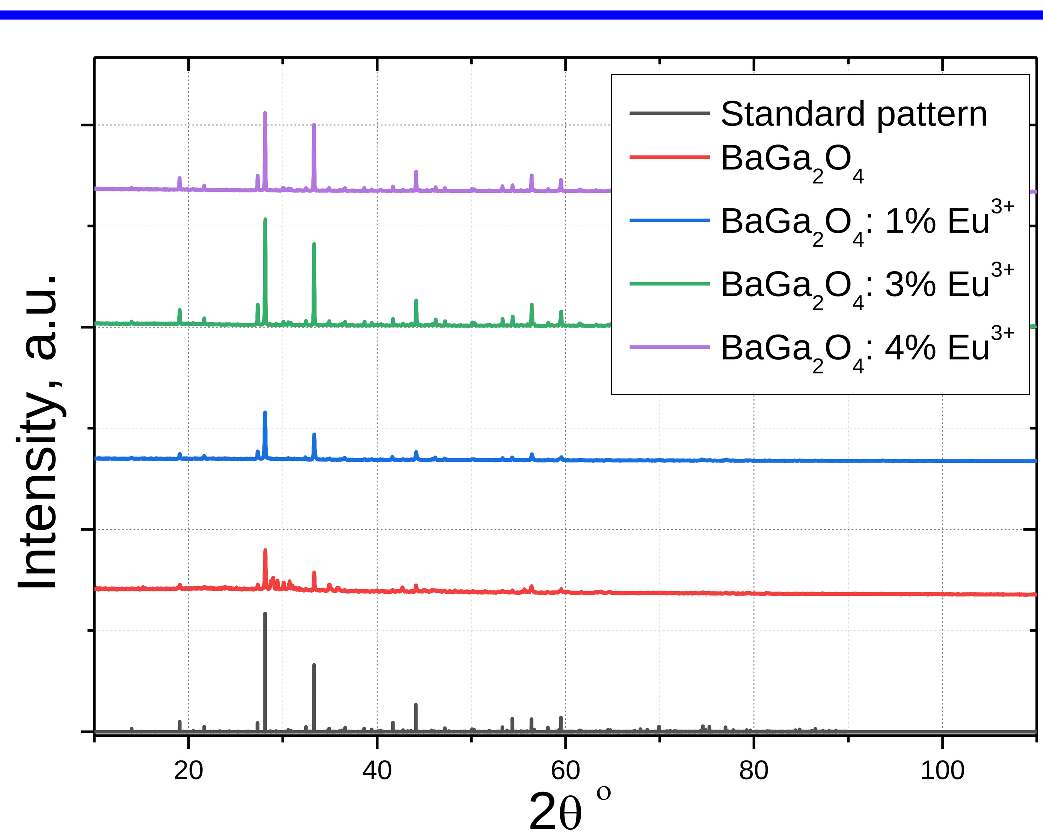


Microstructure of the selected area and elemental composition of $BaGa_2O_4$ ceramics doped with 4 mol% Eu^{3+} ions.

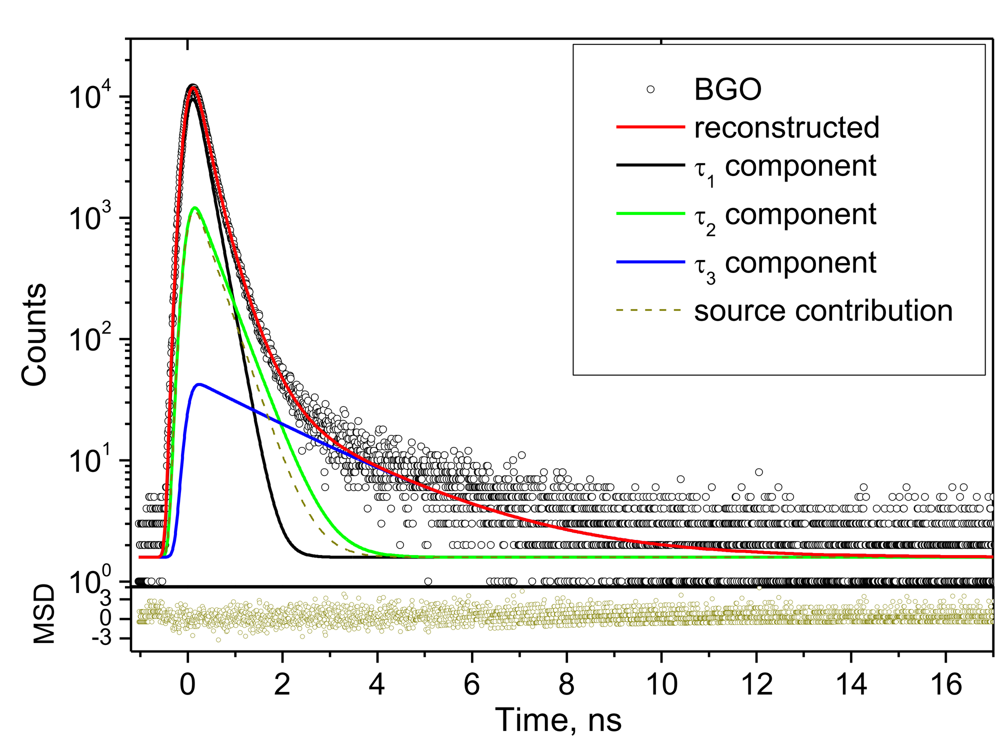


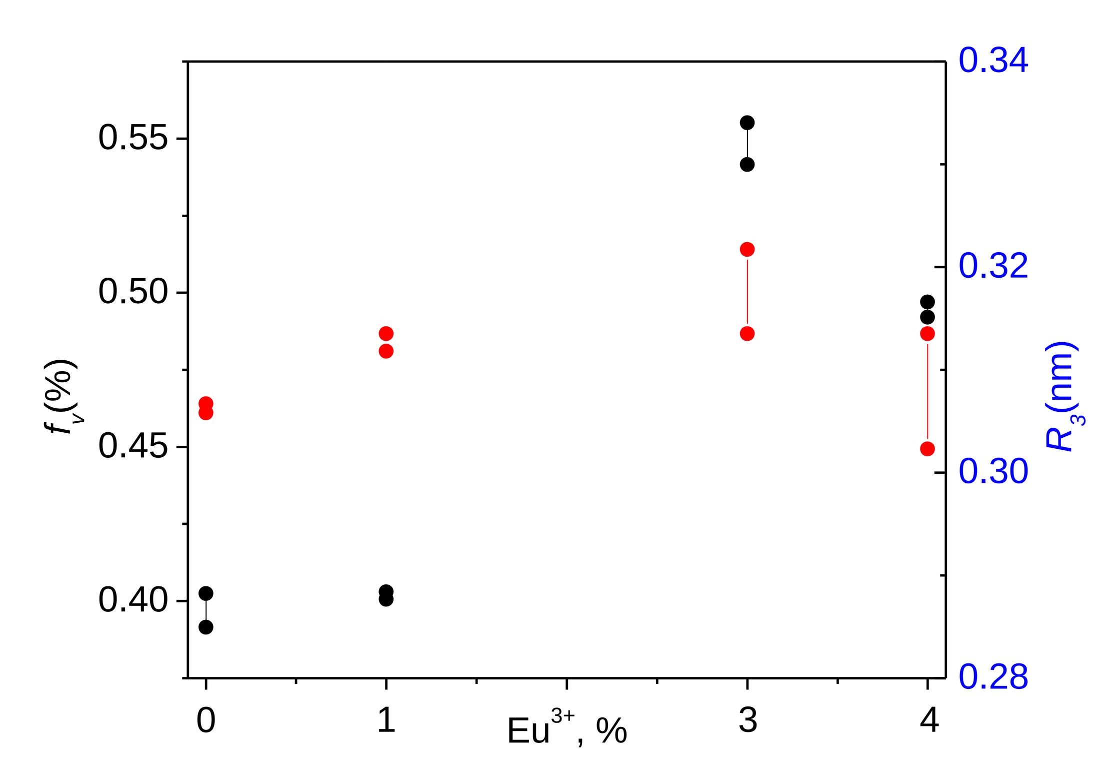


XRD DATA



PAL Results





RESULTS: PAL characteristics

Sample	Fitting parameters							Positron trapping modes					Free volume	
	[fit-1] -	τ_1, ns	I_1, a.u.	τ_2, ns	I_2, a.u.	τ_3, ns	I_3, a.u.	$\tau_{av.}$, ns	τ_b, ns	κ_d, ns-1	$\tau_2-\tau_b$, ns	τ_2/τ_b	R_3, nm	f_3, %
BGO base	0.02	0.200	0.833	0.424	0.149	2.196	0.018	0.234	0.218	0.40	0.21	1.95	0.306	0.39
	0.03	0.200	0.834	0.425	0.148	2.213	0.018	0.234	0.217	0.40	0.21	1.96	0.307	0.40
BG0+1% Eu	0.03	0.208	0.858	0.454	0.125	2.267	0.018	0.239	0.223	0.33	0.23	2.03	0.312	0.40
	0.02	0.206	0.851	0.450	0.132	2.289	0.017	0.239	0.222	0.35	0.23	2.02	0.314	0.40
BG0+3% Eu	0.04	0.211	0.892	0.508	0.084	2.291	0.023	0.237	0.222	0.24	0.29	2.28	0.314	0.54
	0.01	0.212	0.899	0.550	0.079	2.390	0.022	0.240	0.223	0.23	0.33	2.46	0.322	0.56
BG0+4% Eu	0.01	0.201	0.833	0.411	0.144	2.157	0.024	0.232	0.218	0.37	0.19	1.89	0.302	0.49
	0.01	0.206	0.870	0.462	0.109	2.286	0.021	0.235	0.220	0.30	0.24	2.10	0.314	0.50

$\tau_{av.} = \frac{\tau_1 I_1 + \tau_2 I_2}{I_1 + I_2}$	**Mean positron lifetime:** reflects cumulative defect environment prevailing in sample
Lifetime τ_b: associated with the positron trapping in defect-free bulk	$\tau_b = \frac{I_1 + I_2}{\frac{I_1}{\tau_1} + \frac{I_2}{\tau_2}}$
$\kappa_d = \frac{I_2}{I_1}\left(\frac{1}{\tau_b} - \frac{1}{\tau_2}\right)$	**Positron trapping rate in defects**
$\tau_2 - \tau_b$	Size measure of extended defects where positrons are trapped
Represents the nature of defects	τ_2/τ_b