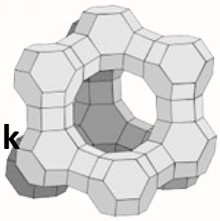
Sorption-luminescence method for determination of cerium using clinoptilolite



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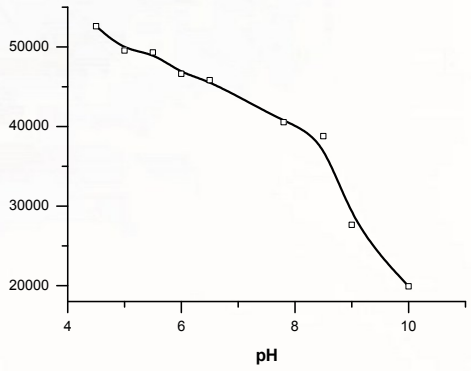
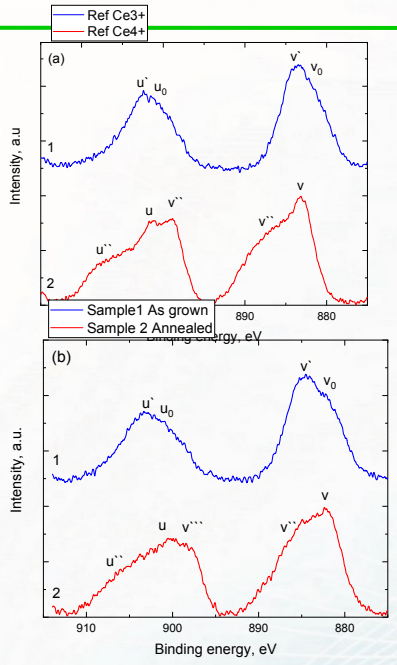
Cerium is the most abundant of the lanthanide elements. Lanthanides reveal almost identical chemical properties. However, lanthanides essentially differ in their optical properties, in particular, the ability for absorption and emission of excitation energy. This luminescence (LM) is specific for each lanthanide. This fact is the basis for selective luminescent methods of lanthanides determination. Sorption of elements being determined on the solid matrix is one of the efficient methods that can increase a sensitivity and selectivity of LM determination. The Ce(III)–clinoptilolite samples were obtained via lanthanide ions sorption from aqueous solutions at pH 4.5 on the zeolite in a solid phase extraction mode. For the excitation of LM samples rays with the wavelength of 255 nm were used. The intensity of the LM at 346 nm was chosen as an analytical parameter for the quantitative determination of Ce. The oxidation of Ce^{3+} to Ce^{4+}, which occurs during calcination of the Ce^{3+}– clinoptilolite sample at 500 ˚C, leads to complete disappearance of LM of this luminophore. Linear calibration range of Ce^{3+} concentration with the detection limit of 5 ng·mL^{-1} is within 14–190 ng·mL^{-1}. The proposed method can be used for cerium determination in the presence of many rare earths.



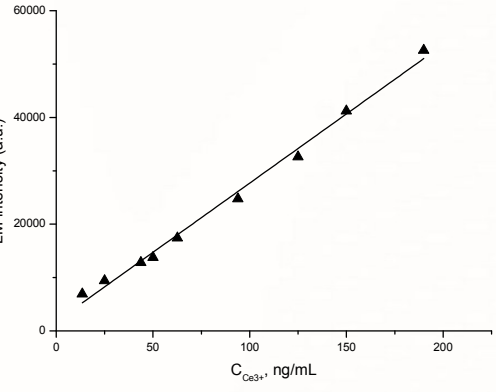
he dependence of the luminescence intensity of Ce(III)-clinoptilolite composite on the pH value of Ce^{3+} solution.

Tolerance limits of RE ions for luminescent of cerium

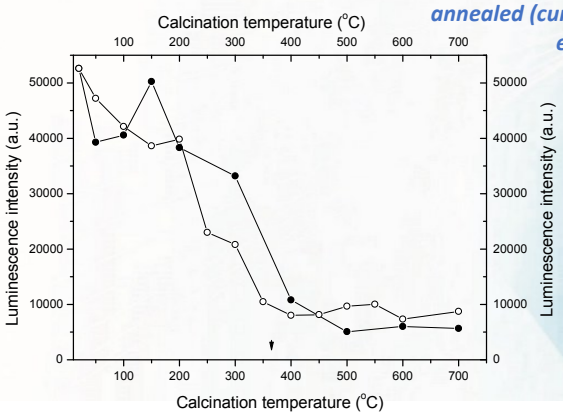
Ion	Tolerance limit (C_{ion} / $C_{Ce(III)}$)
Y^{3+}	25
Pr^{3+}, Gd^{3+}	20
Eu^{3+}	10
Lu^{3+}, Nd^{3+}, Er^{3+}, Tb^{3+}	5
Sm^{3+}	3
Tm^{3+}	2
Dy^{3+}	1
Yb^{3+}	0.5
La^{3+}, Ho^{3+}	0.1
Sc^{3+}	0.05



[CeXPS] Ce 3d core level spectra: (a) Ce^{3+} (curve 1) and Ce^{4+} (curve 2) from reference powders $Ce_2(SO_4)_3$ and CeO_2, respectively; (b) as-grown (curve 1) and annealed (curve 2): Ce samples. The excitation energy was 1254 eV.



Calibration curve for luminescent cerium determination



Dependence of luminescence intensity of the "clinoptilolite–Ce(III)" luminophore on the temperature of precalcination of clinoptilolite (o) and clinoptilolite–Ce(III) (•)