LUMINESCENCE OF NANO- AND MICROCRYSTALS EMBEDDED IN HALIDE MATRICES

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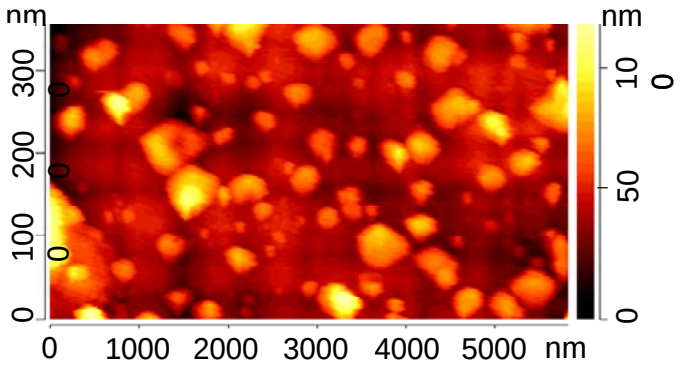
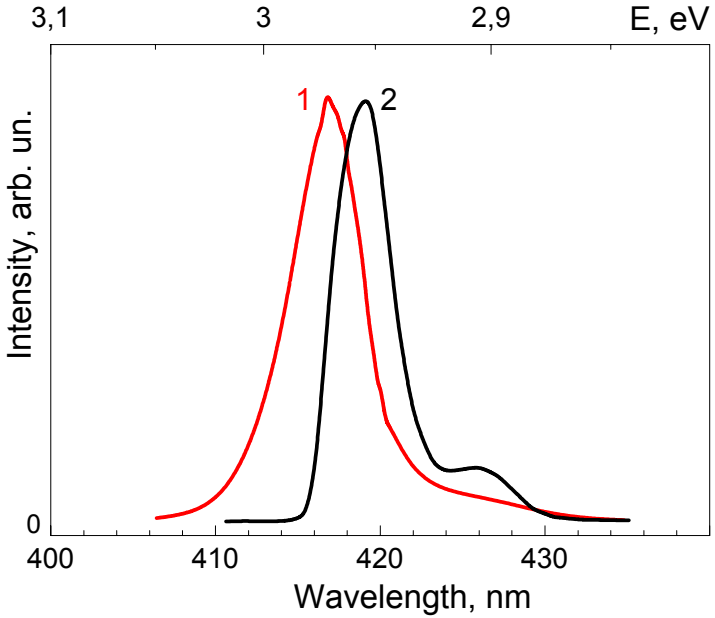
$CsPbX_3$ nanoparticles in CsX matrix (X=Cl, Br)
on example of chlorine composite system

AFM image

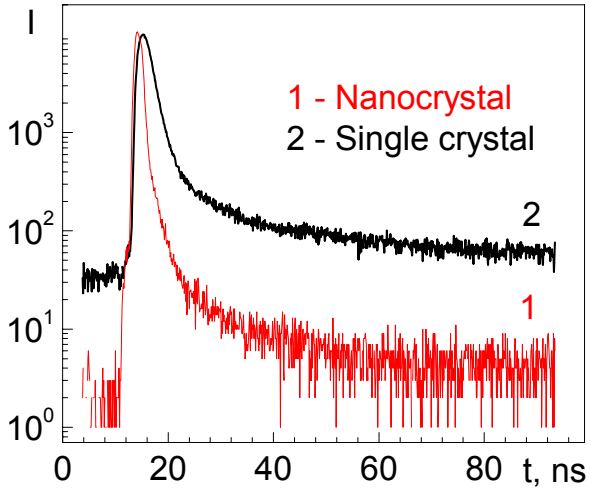


Increased luminescence intensity



Shortening of excitons decay time

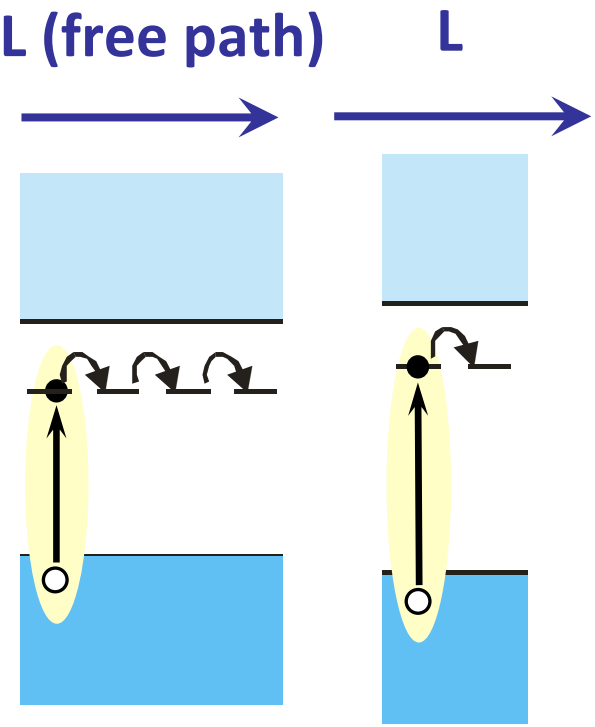
τ=50 ps (nanocrystal)



τ=500 ps (single crystal)

Coherent effects

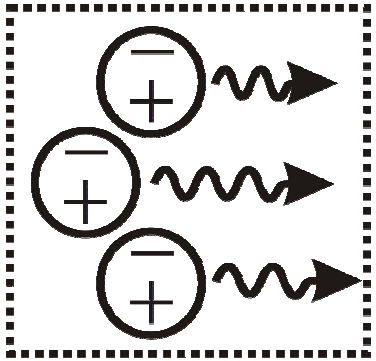
Superluminescence



bulk nano

L<R_{QD}

Incoherent excitons

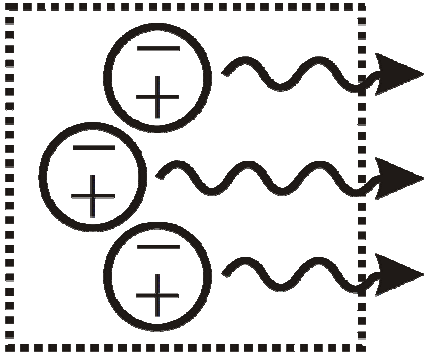


$I_{coh}=N^2I_0$

bulk

L>R_{QD}

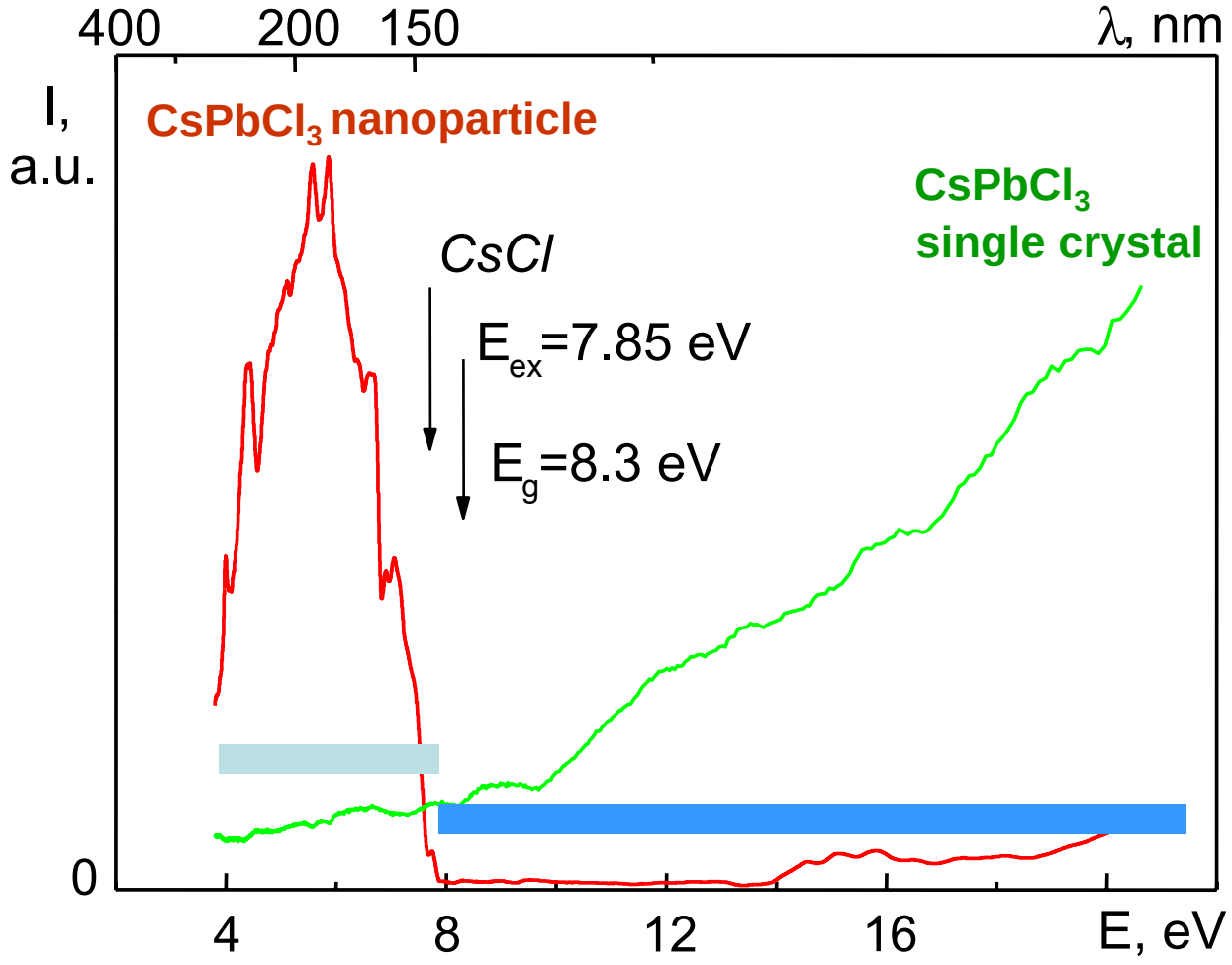
Coherent excitons



$\tau_{coh} \sim \tau_{incoh}/N$

nano

Excitation spectra

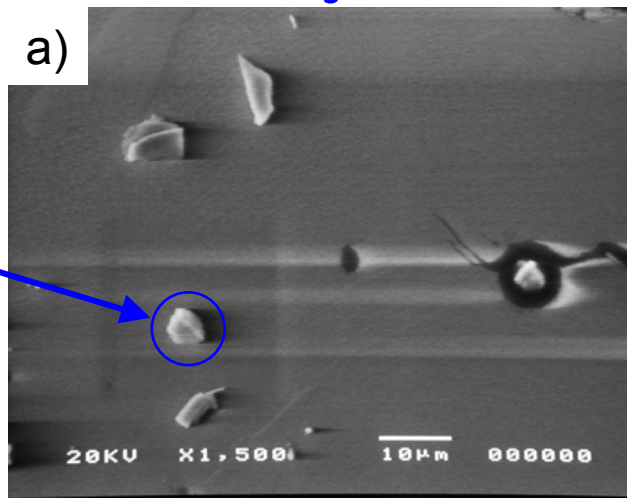


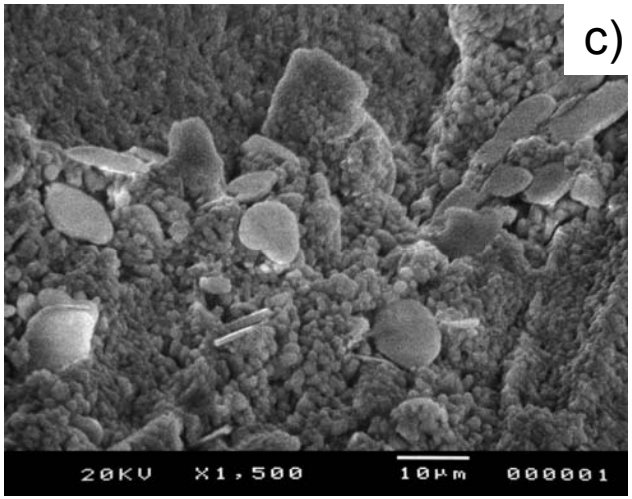
Ce^{3+} activated LaX_3 particles embedded into NaX hosts (X=Cl, Br, I)

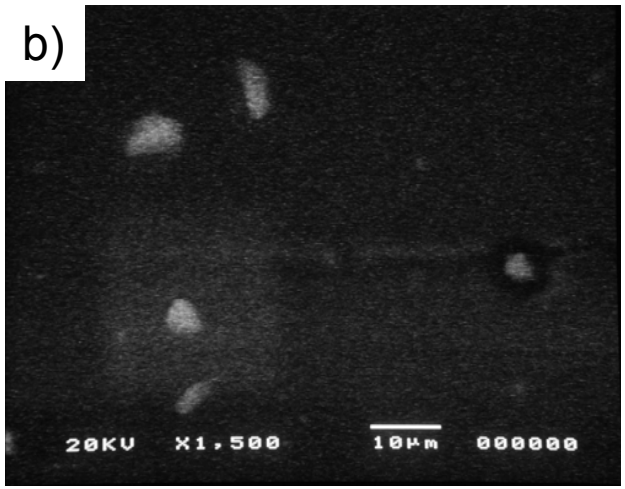
NaBr-$LaBr_3$-Ce

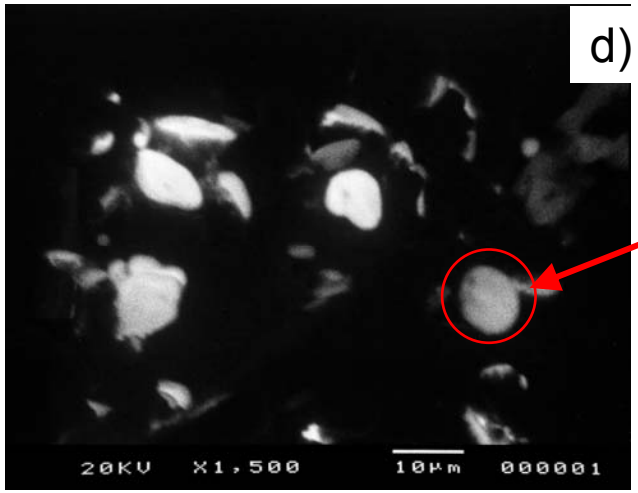
NaI-LaI_3-Ce

$LaBr_3$-Ce





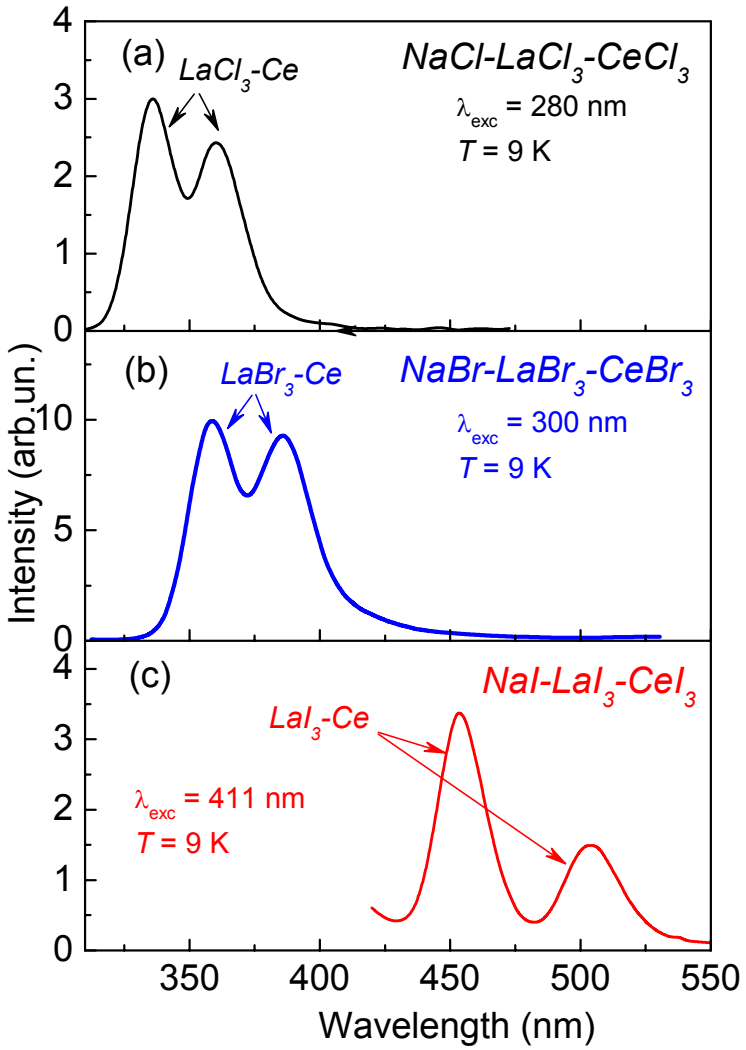




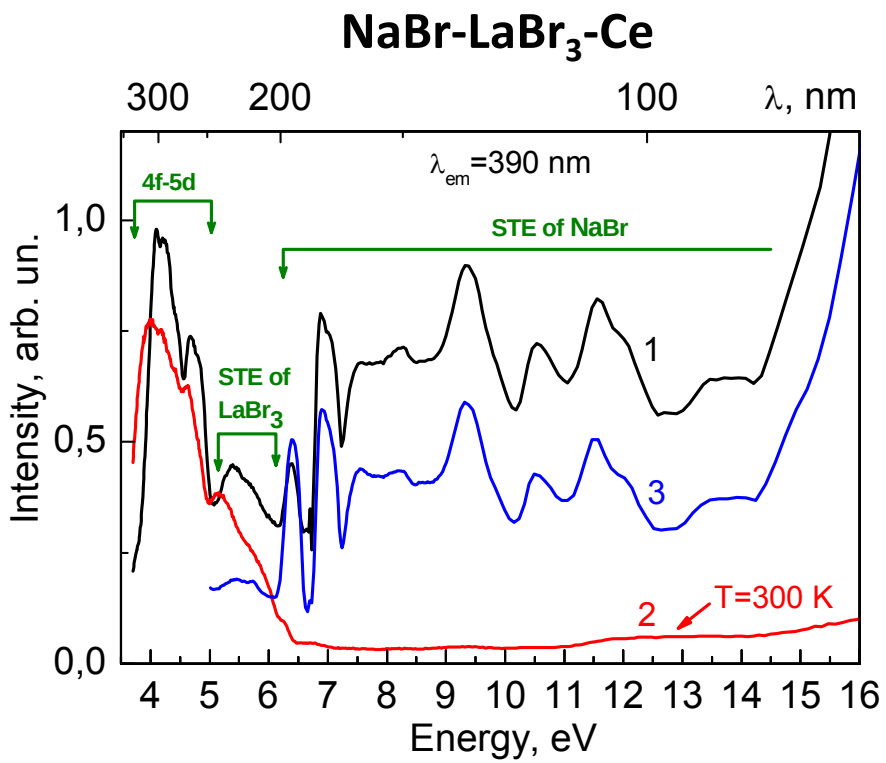
LaI_3-Ce

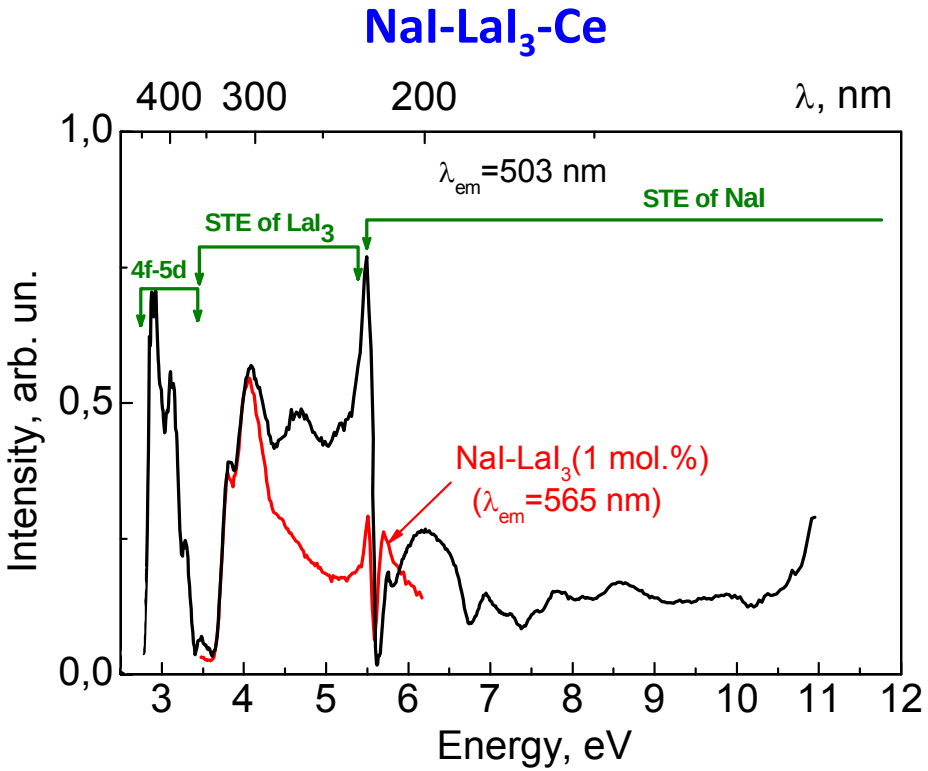
Micrographs of NaX-LaX_3-Ce fresh cleaved surface obtained by: secondary electron registration mode (a, c), cathodoluminescence mode (b, d)

Luminescence spectra

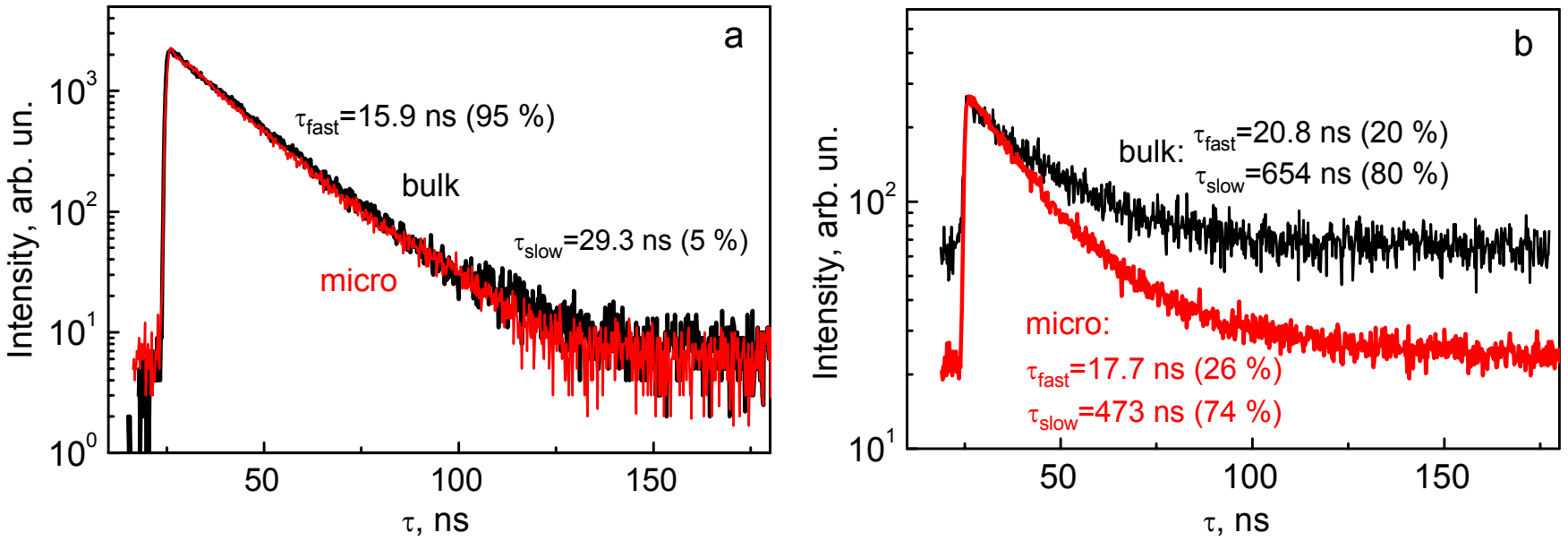


Excitation mechanisms of Ce^{3+} luminescence



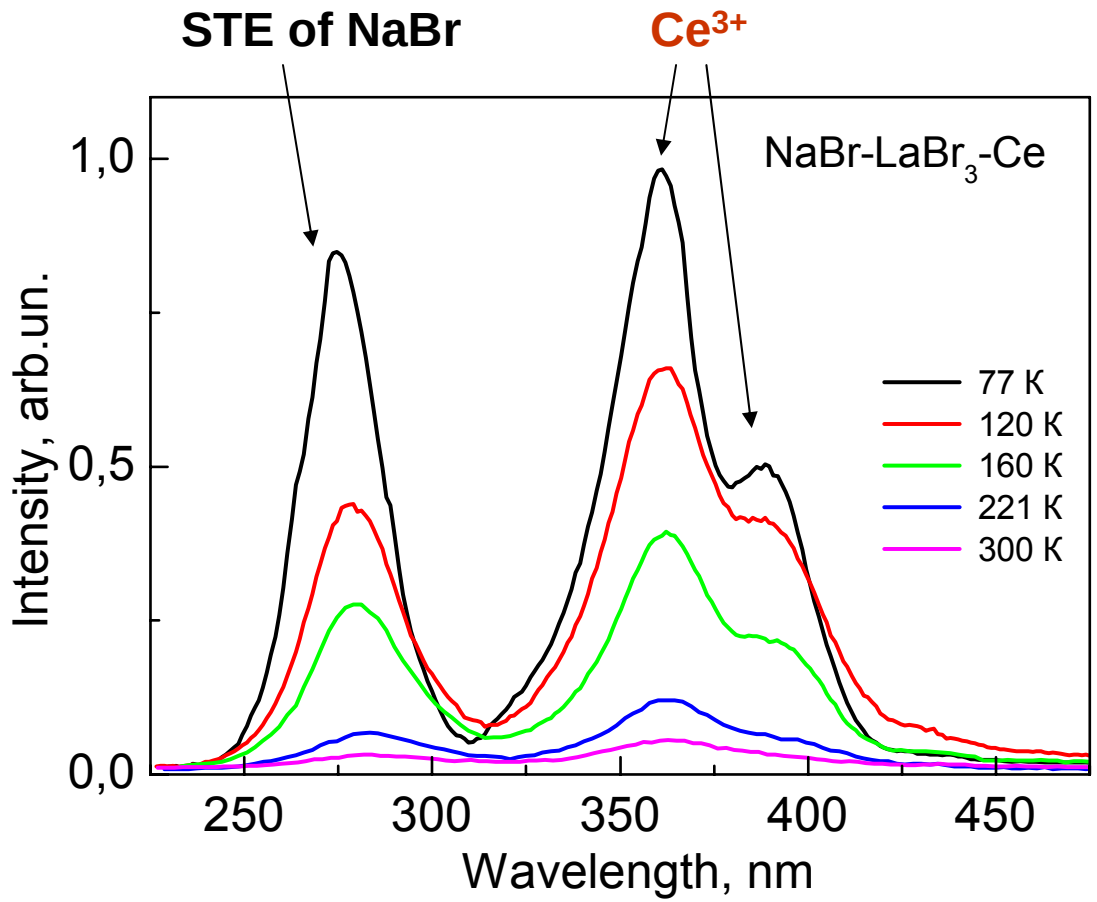


Decay kinetics



Smaller quantity of carrier trappings in microcrystalline phase (on example of $LaCl_3$:Ce microcrystals embedded into NaCl)

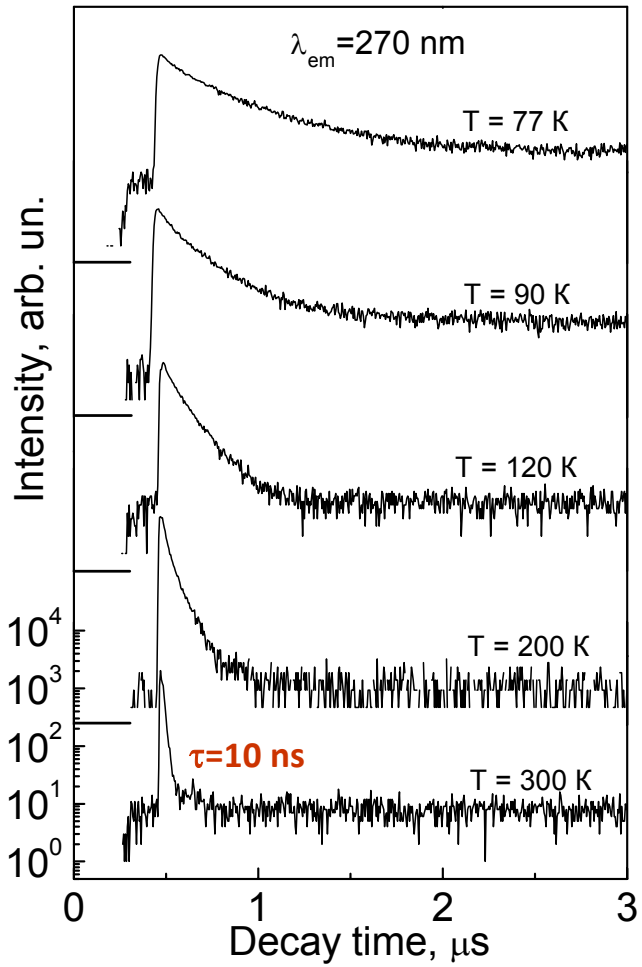
X-ray excited luminescence spectra



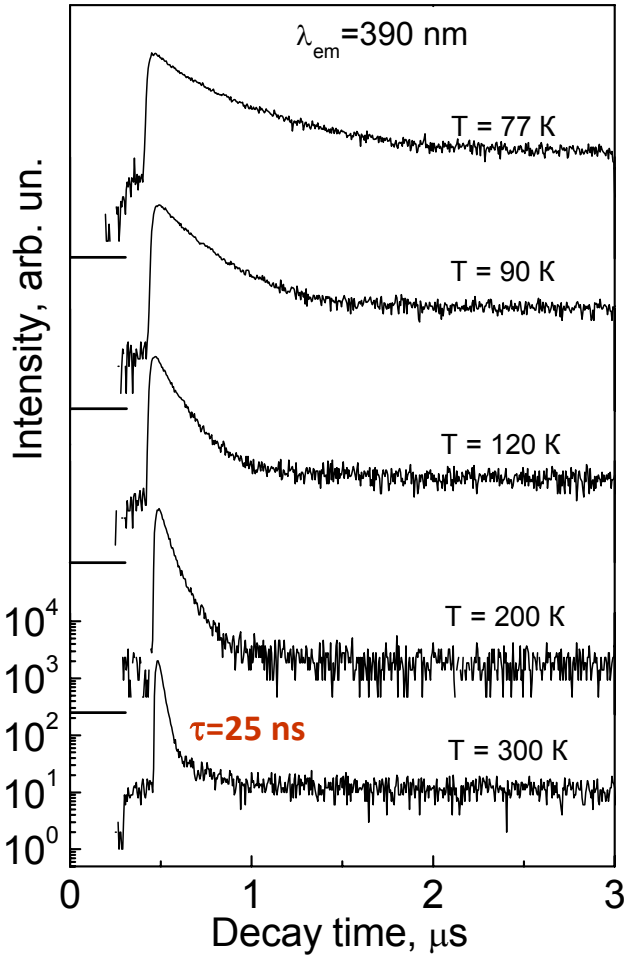
Excitation of Ce^{3+} centers by the reabsorption of the STE emission of a host

X-ray excited decay kinetics

Decay kinetics of STE of NaBr



Decay kinetics of Ce^{3+} centers in $LaBr_3$ microcrystals

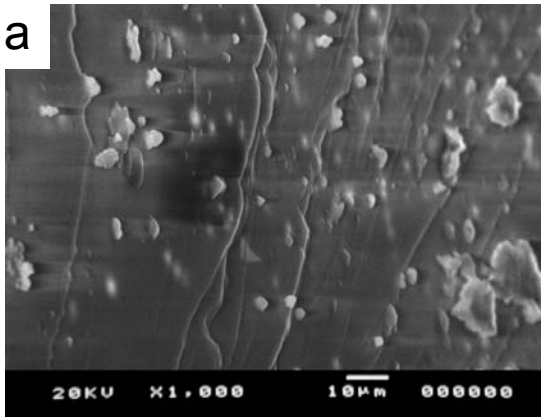


Eu^{2+} activated MeX_2 particles embedded into NaX (Me=Sr, Ba; X=Cl, I)

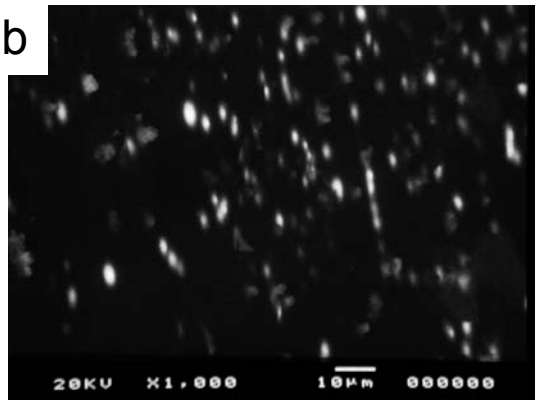
NaCl-$SrCl_2$(1 mol.%)-$EuCl_3$(0.02 mol.%)

NaCl-$BaCl_2$(1 mol.%)-$EuCl_3$(0.02 mol.%)

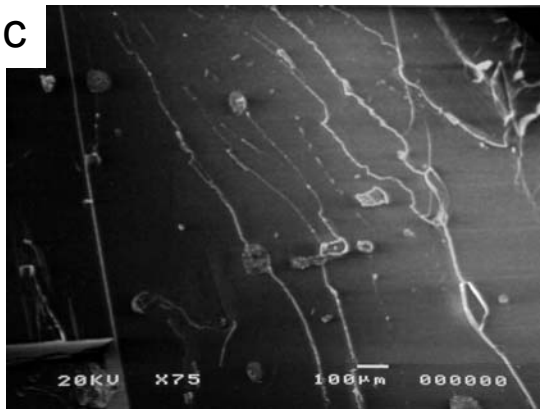
a



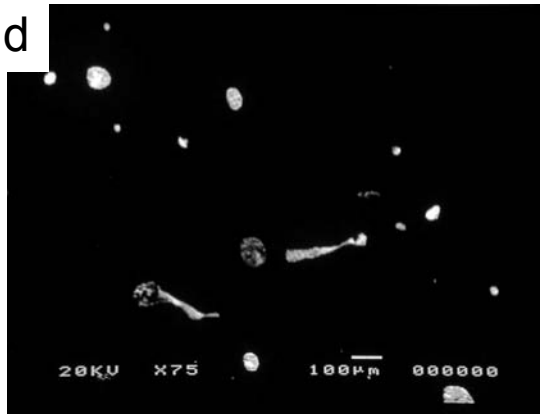
b



c

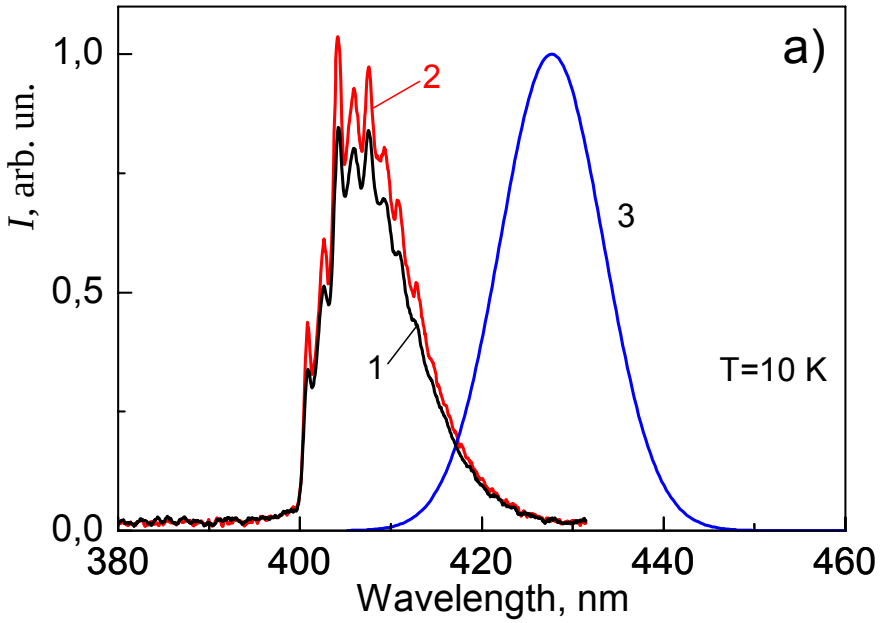


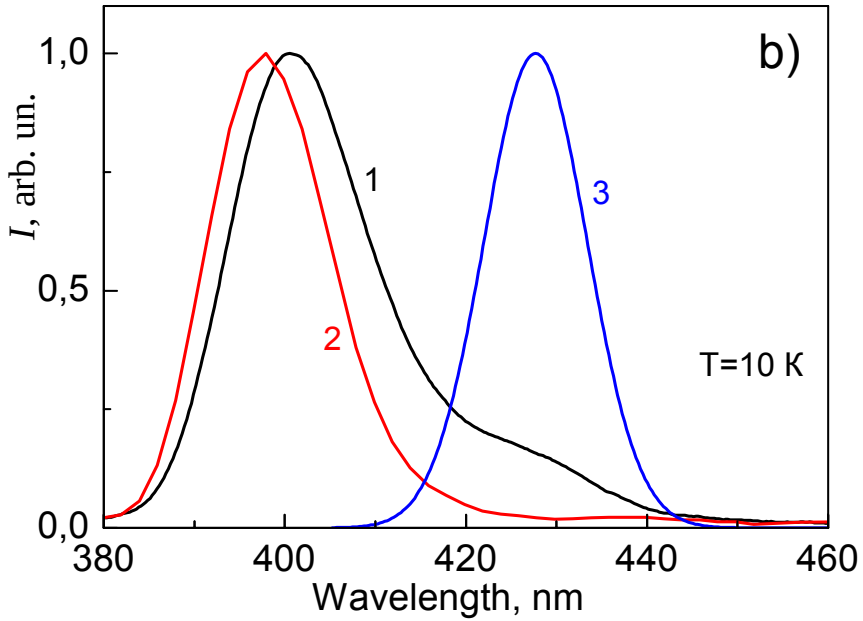
d



Micrographs of NaCl-$MeCl_2$-Eu freshly cleaved surface obtained by: secondary electron registration mode (a, c), cathodoluminescence mode (b, d)

Entering of Eu^{2+} ions in $MeCl_2$ microcrystals

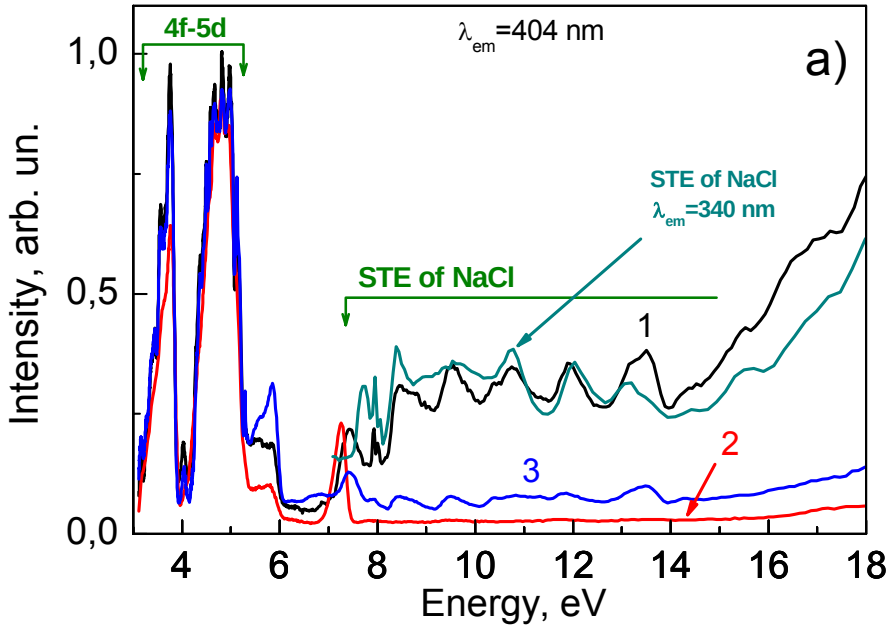


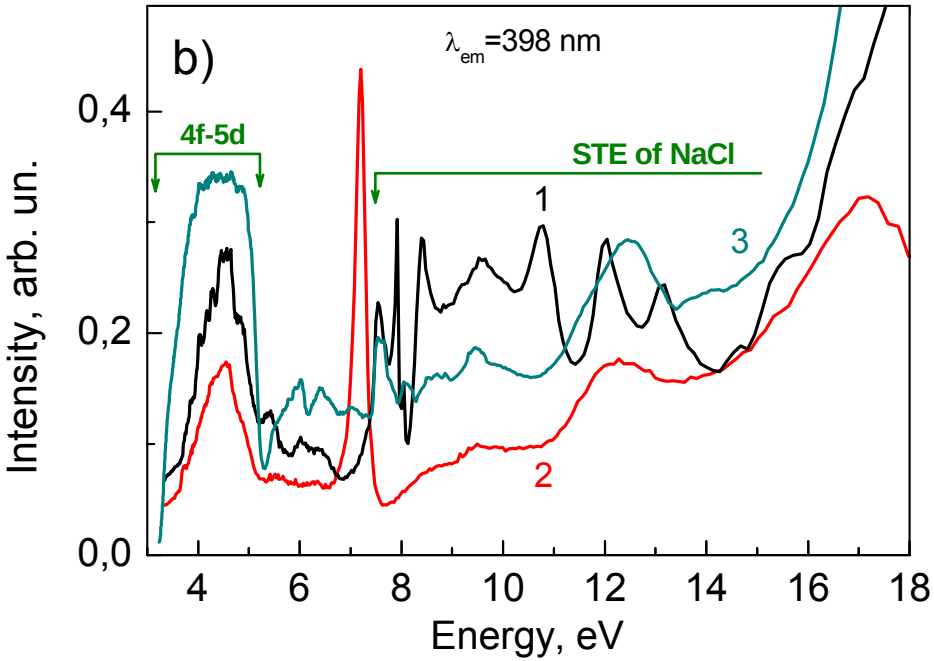


a): λ_{exc}=330 nm
1 – $NaCl\text{-}SrCl_2\text{-}Eu$
2 – $SrCl_2\text{-}Eu$
3 – NaCl-Eu

b): λ_{exc}=300 nm
1 – $NaCl\text{-}BaCl_2\text{-}Eu$
2 – $BaCl_2\text{-}Eu$
3 – NaCl-Eu

Excitation mechanisms of Eu^{2+} luminescence

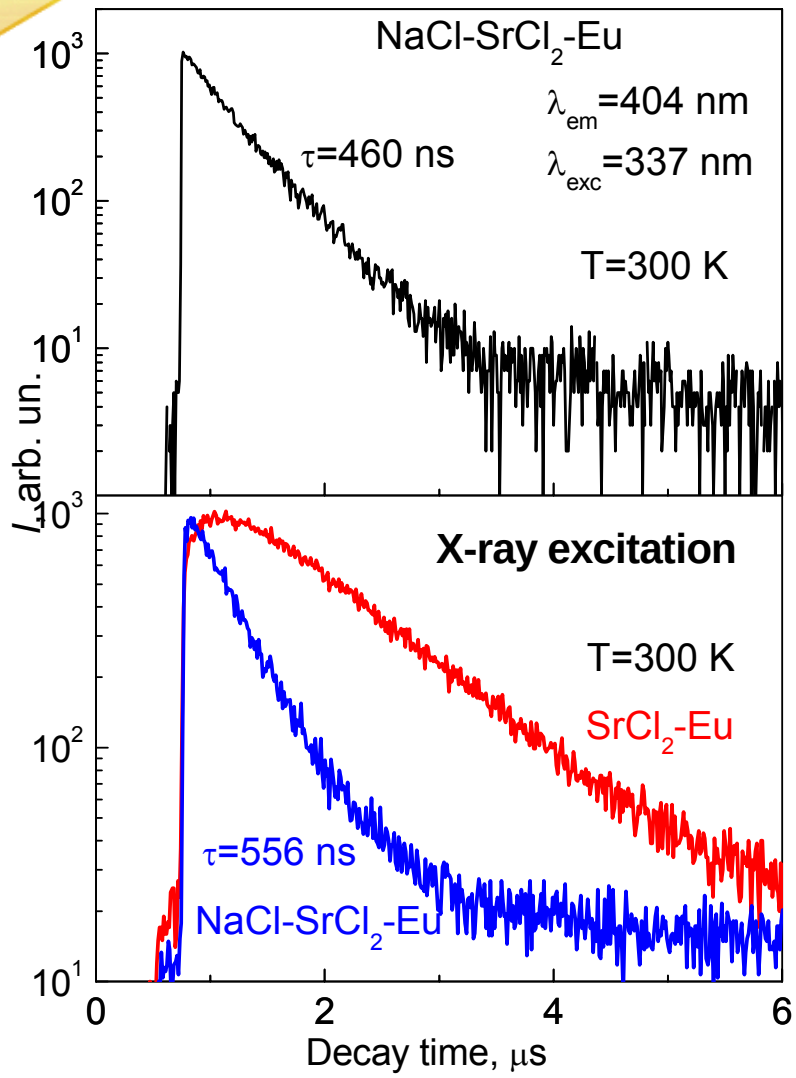


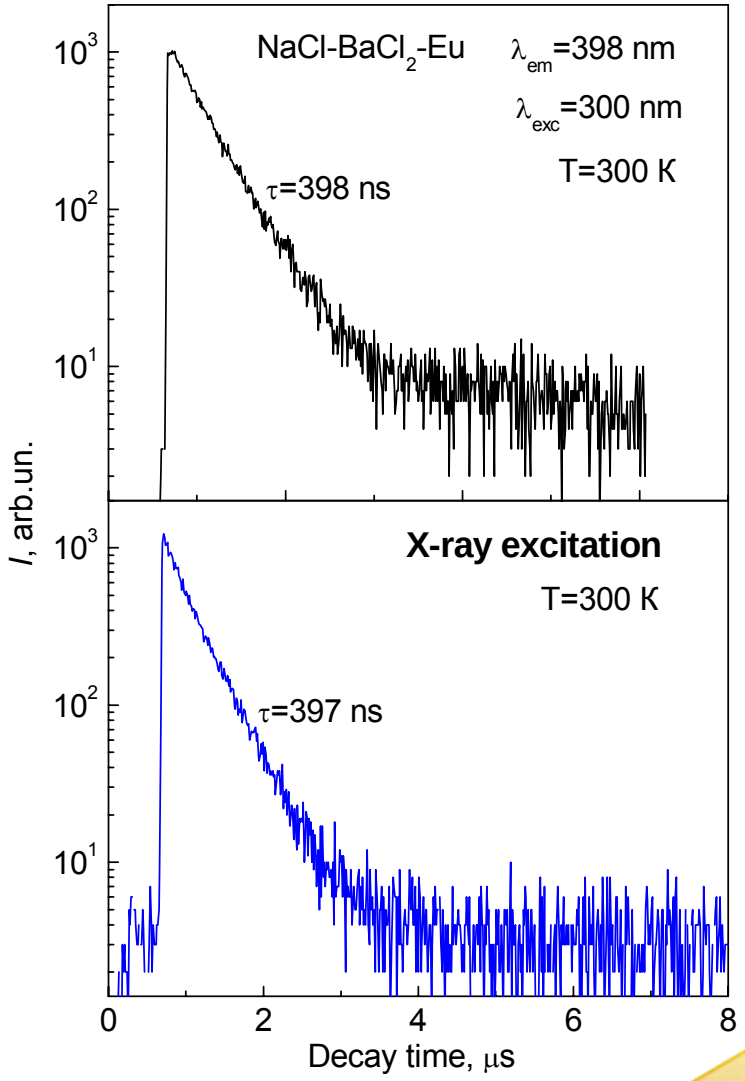


a):
λ_{em}=404 nm
1 – NaCl-$SrCl_2$-Eu (10K)
2 – NaCl-$SrCl_2$-Eu (300K)
3 – $SrCl_2$-Eu

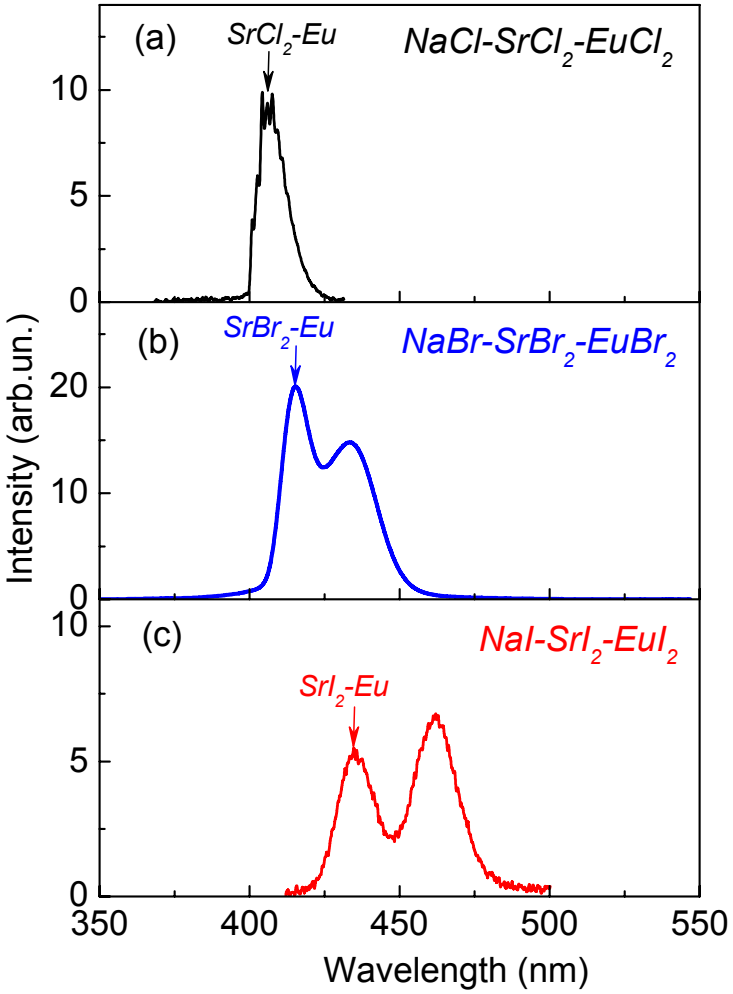
b):
λ_{em}=398 nm
1 – NaCl-$BaCl_2$-Eu (10K)
2 – NaCl-$BaCl_2$-Eu (300K)
3 – $BaCl_2$-Eu

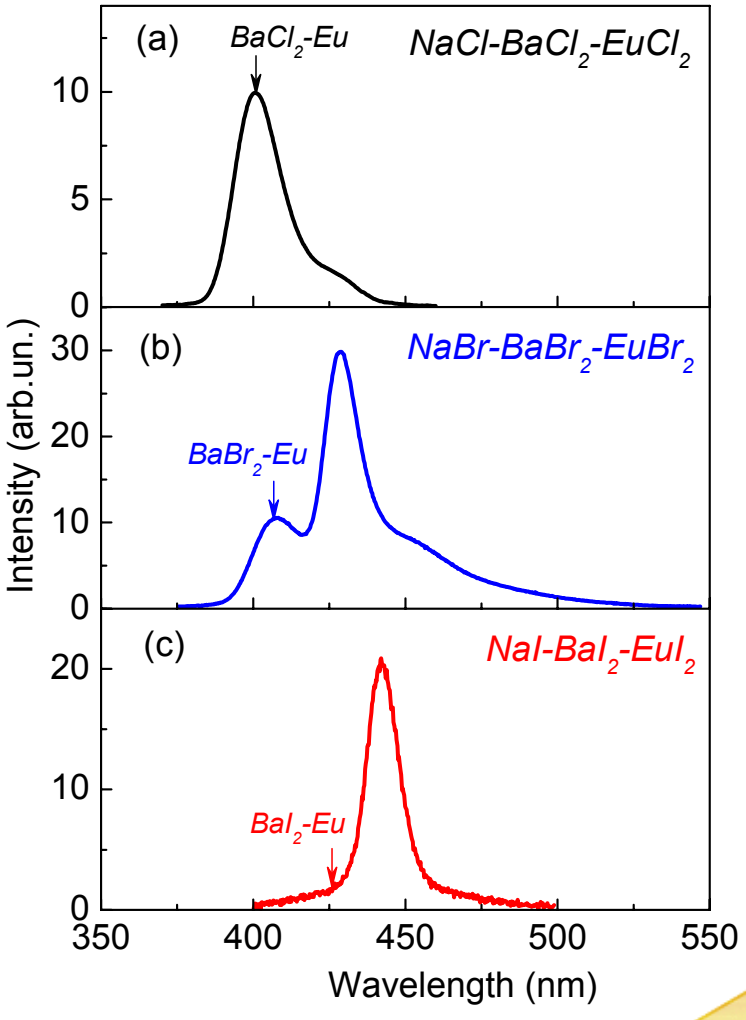
Decay kinetics





Effect of anion substitution on aggregation processes





Conclusions

The increase of excitonic luminescence intensity and shortening of decay time were revealed for $CsPb(Cl, Br)_3$ nanoparticles embedded into Cs(Cl, Br) host that could be explained by the coherent effects manifestation

The efficient formation of Ce^{3+} and Eu^{2+} doped lanthanum, strontium and barium halide microcrystals was shown into more stable natrium halide hosts. The luminescence properties are similar to the ones of corresponding single crystals. Smaller amount of carriers trapping was registered for embedded particles

The excitation mechanisms of activator luminescence were established for optical and X-ray excitations

Thank you for your attention!