



INSTITUTE OF SOLID STATE PHYSICS
UNIVERSITY OF LATVIA

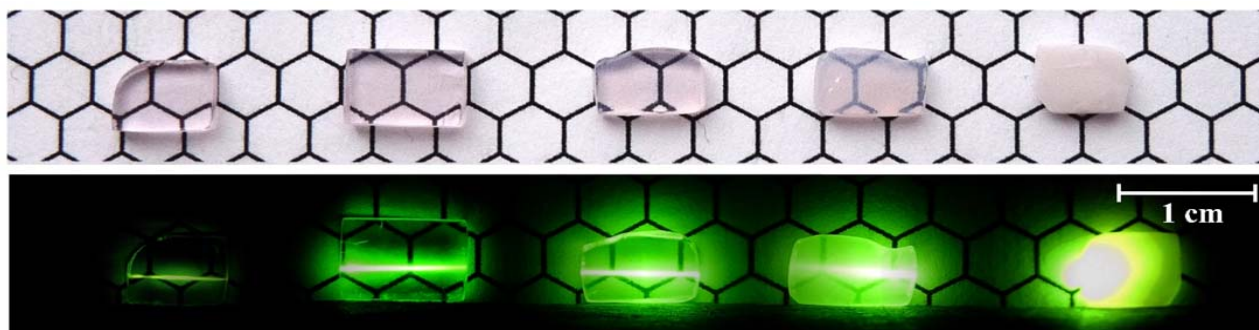


Upconversion luminescence of erbium doped oxyfluoride glass ceramics with β -NaYF₄ nanocrystals

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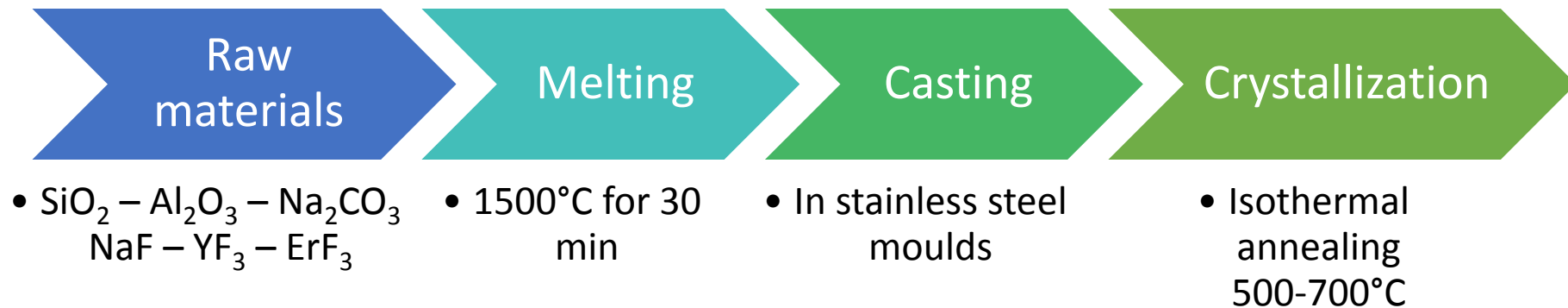


FAST meeting, Prague WG2, 14 June, 2018

Oxyfluoride glass ceramics

Composites – fluoride crystals dispersed in glass matrix

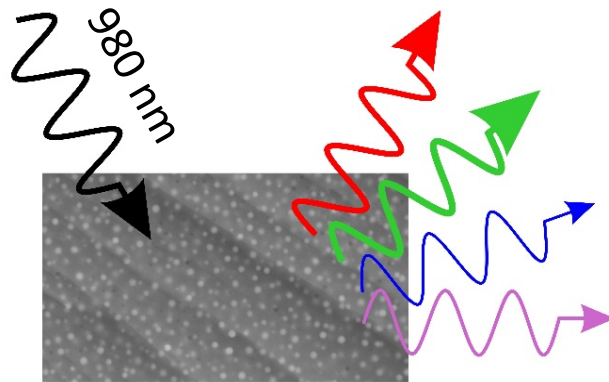
- Low phonon energy of fluoride crystals + mechanical and chemical properties of oxide glass



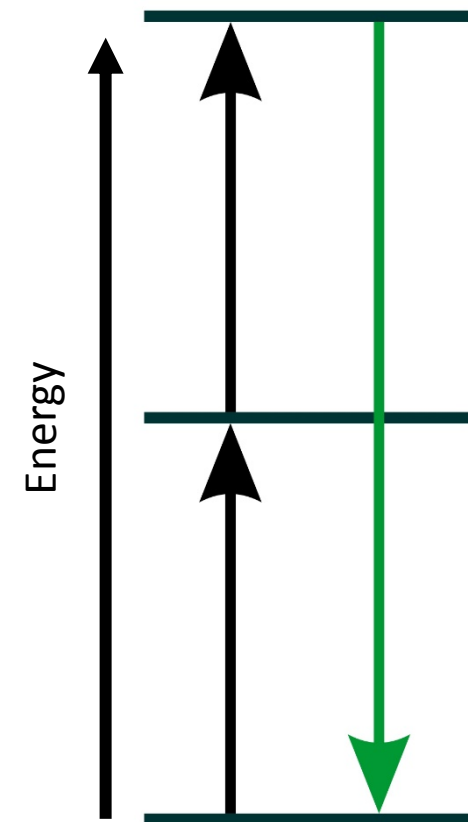
- Bulk crystallization - no agglomeration of crystals
- Can be transparent
- Dopants (rare earth) mostly incorporate in crystallites

Upconversion luminescence

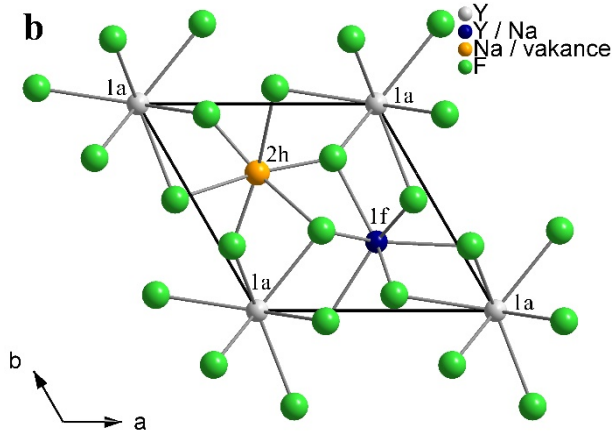
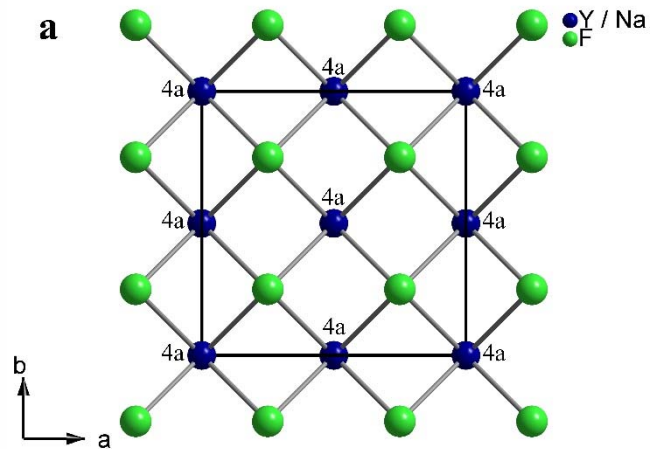
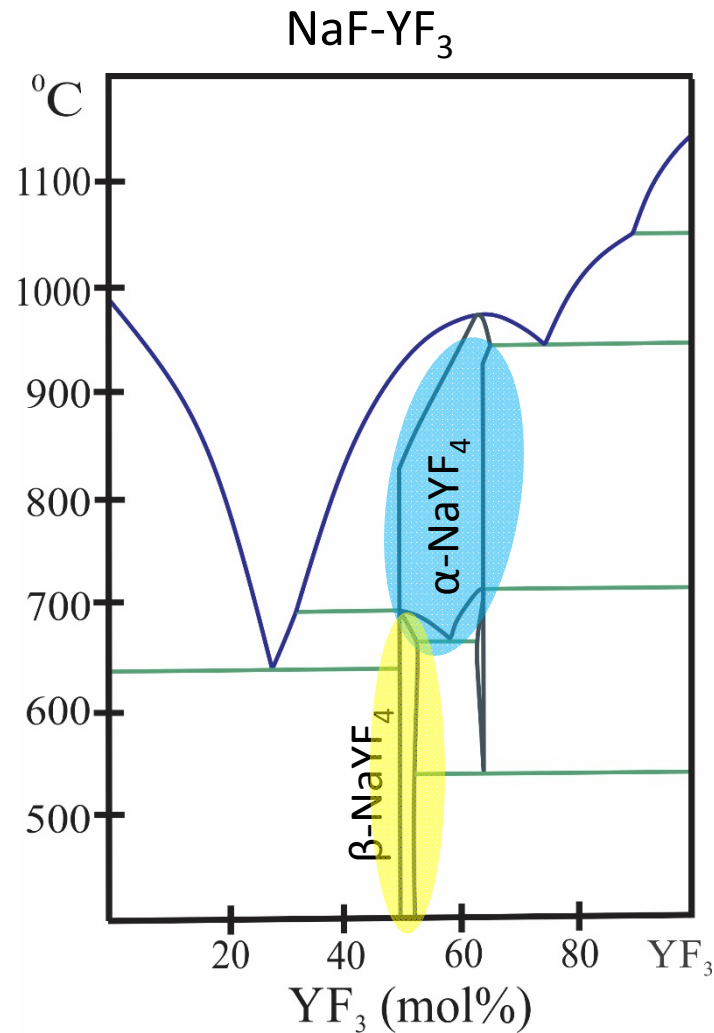
- Emitted photons have higher energy than those used for the excitation
- Highest efficiency observed in materials doped with trivalent rare earth ions
- In Er^{3+} doped materials – NIR (1550, 980 or 800 nm) to visible and UV



Er^{3+} doped glass ceramics



NaYF₄



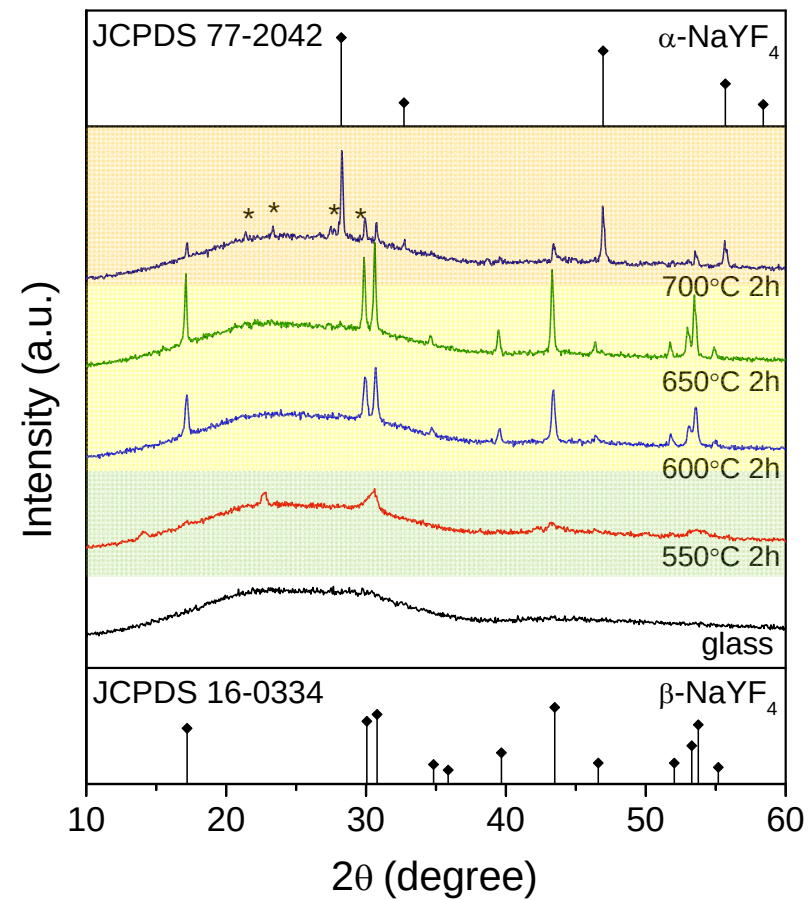
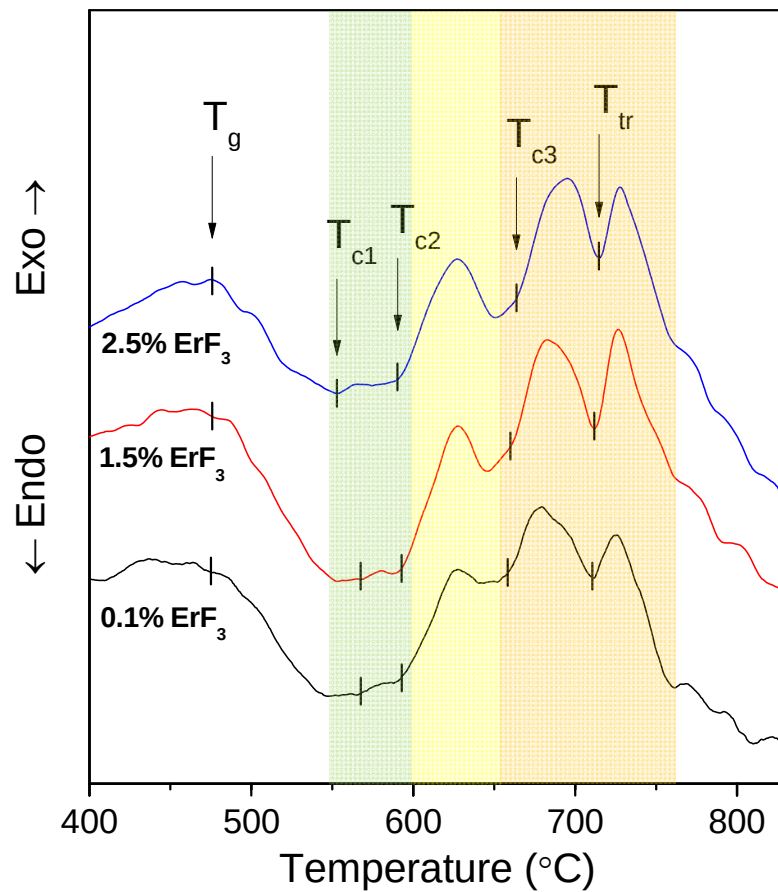
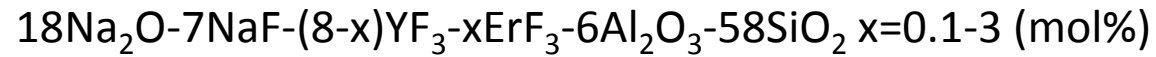
CUBIC

- Can be grown from melt
- Lower upconversion efficiency than β

HEXAGONAL

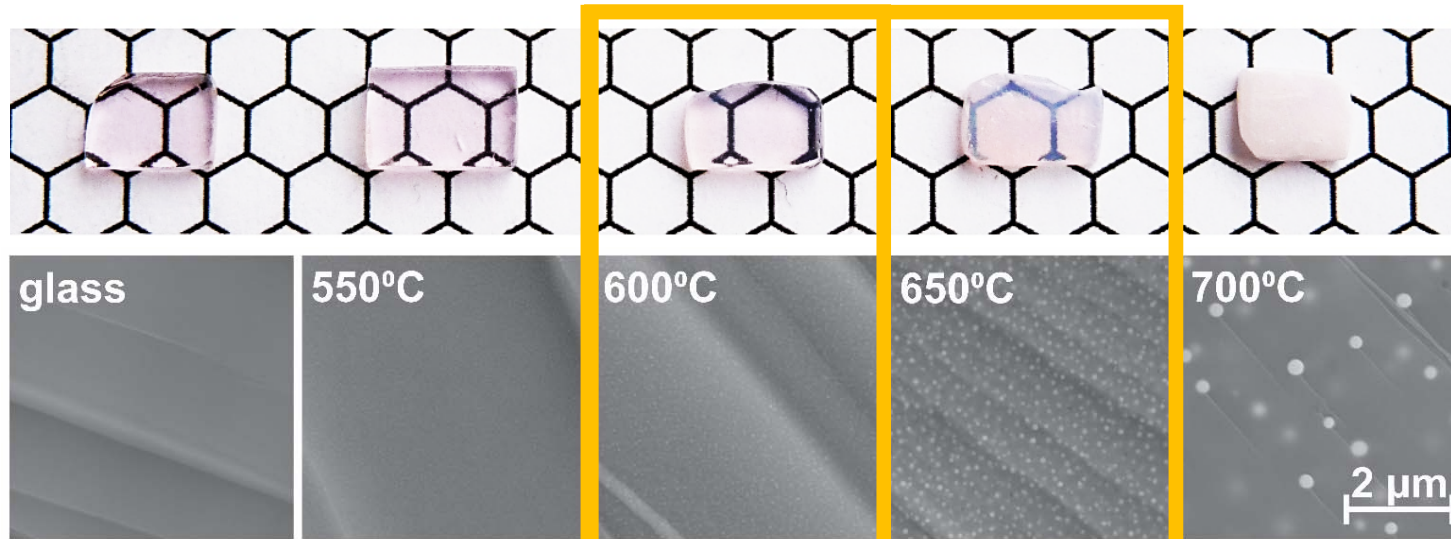
- The most efficient host for upconversion
- Single crystals cannot be grown from melt

Crystallization

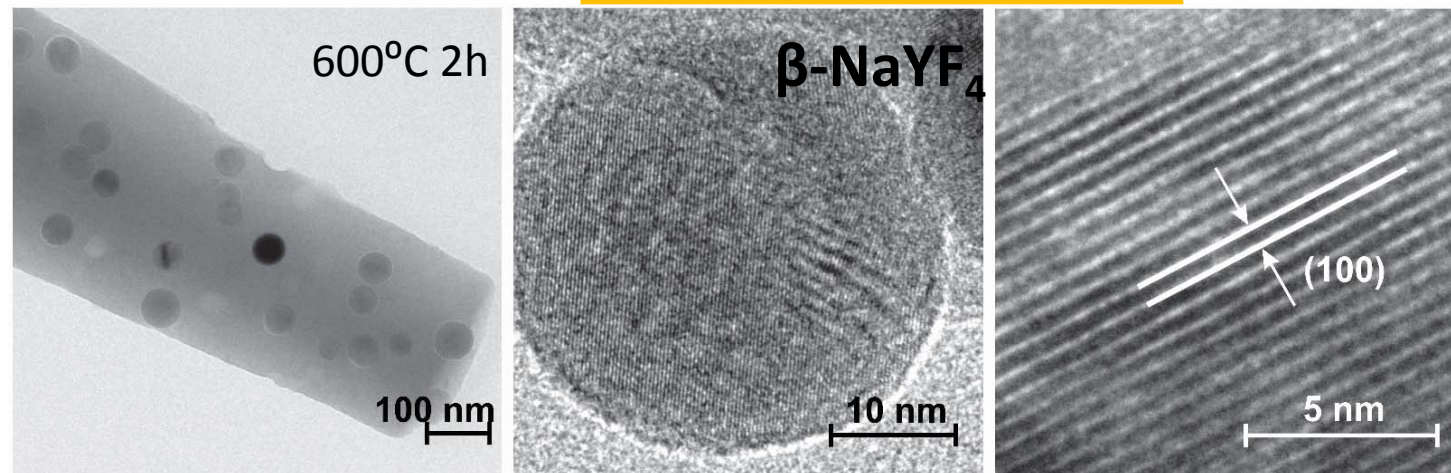


Microstructure

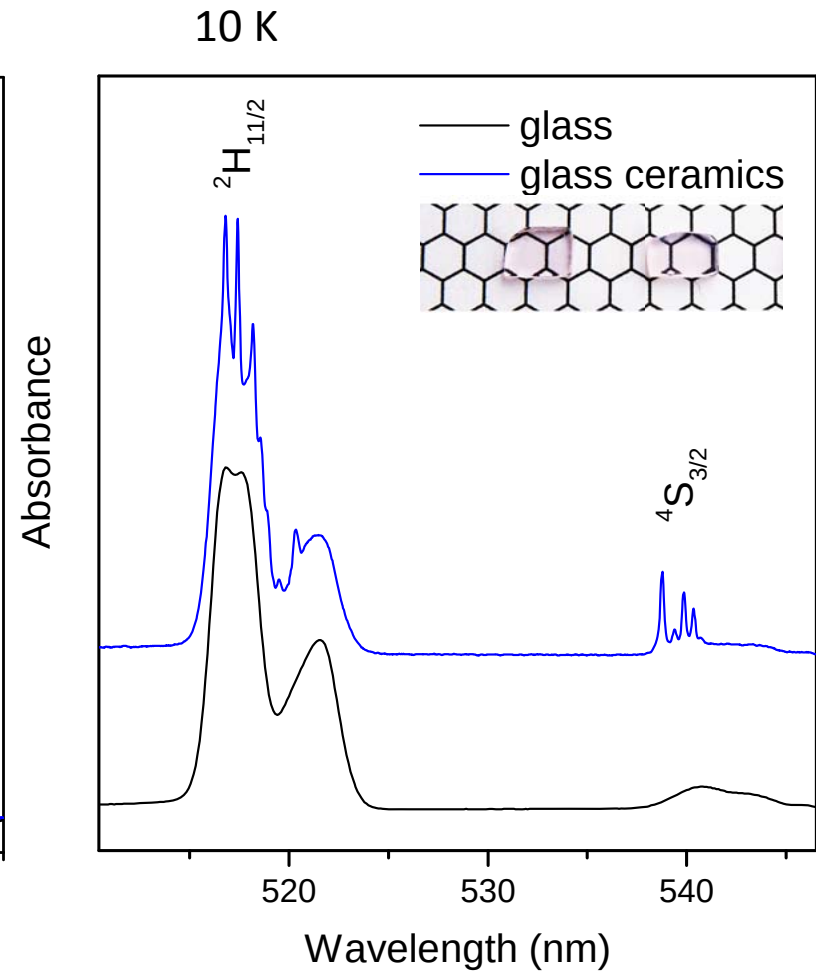
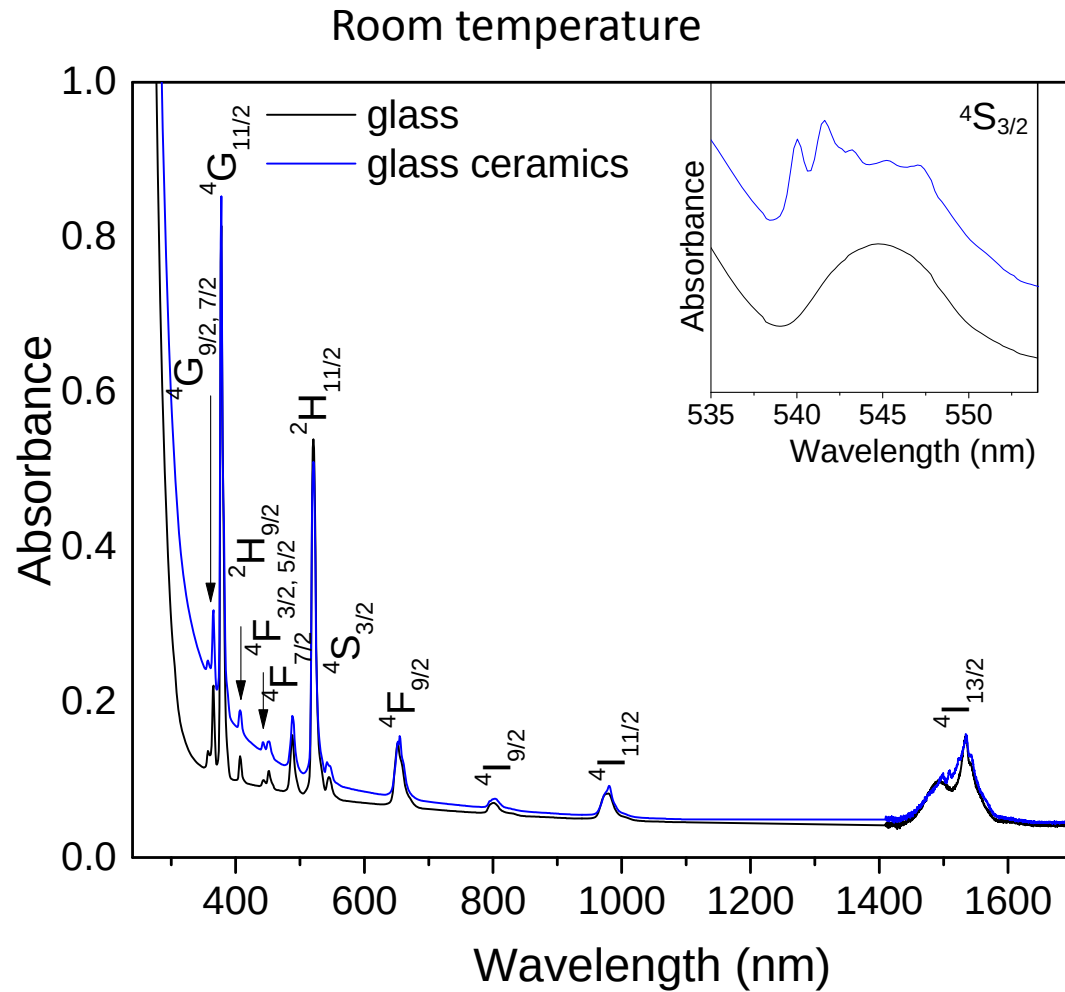
SEM



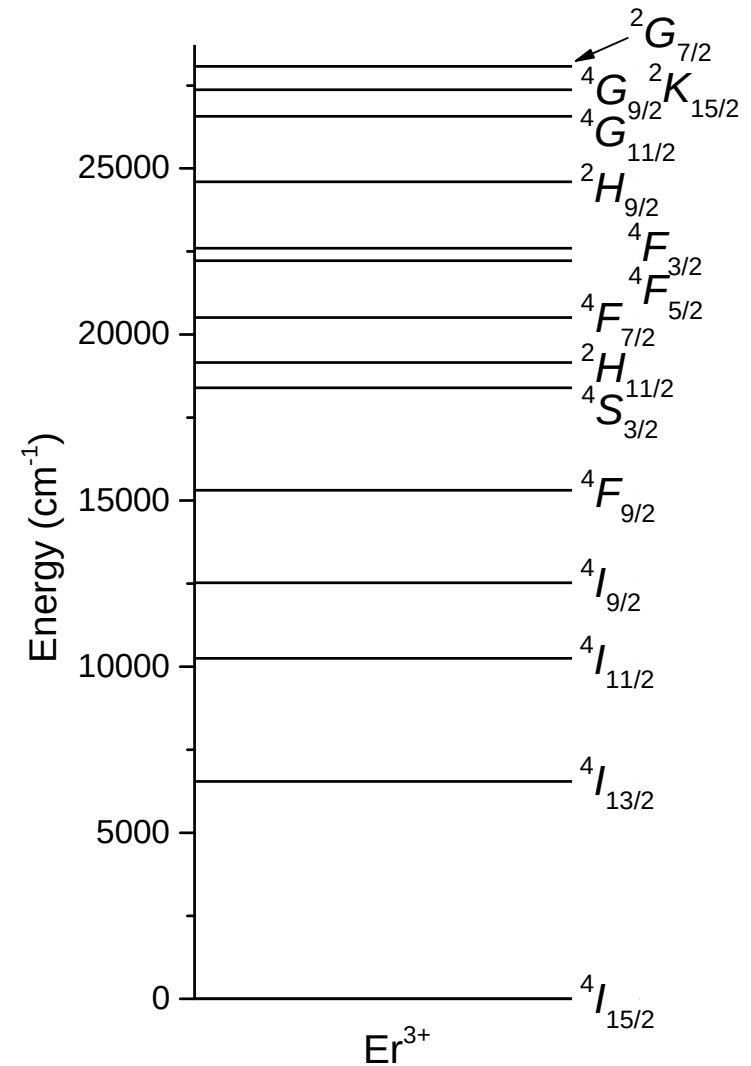
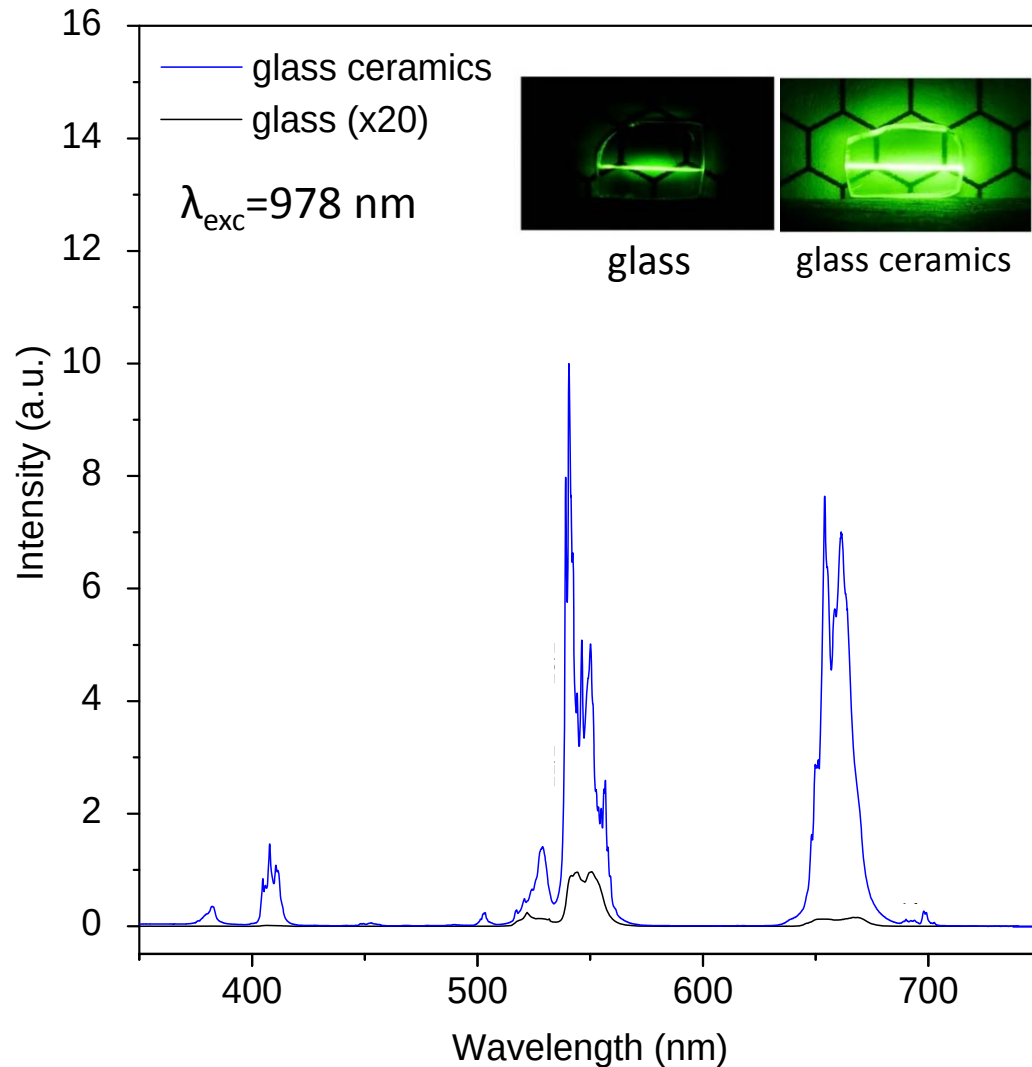
TEM



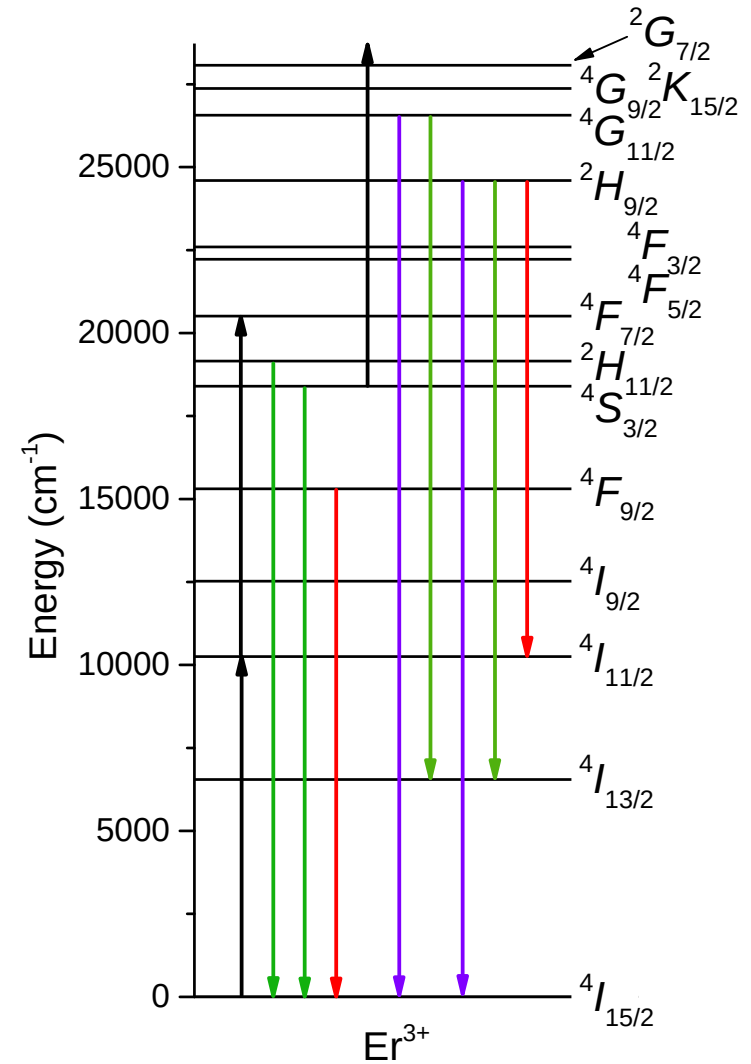
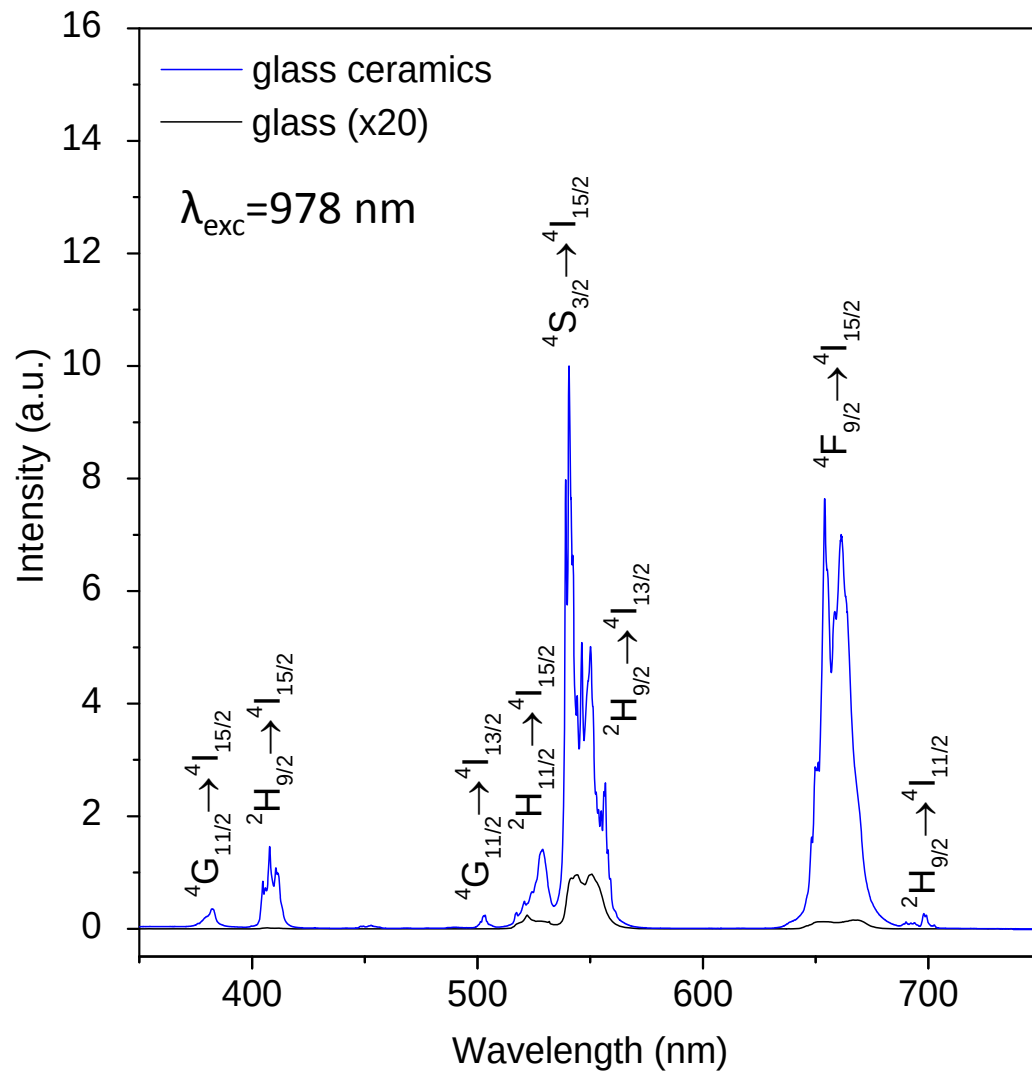
Absorption



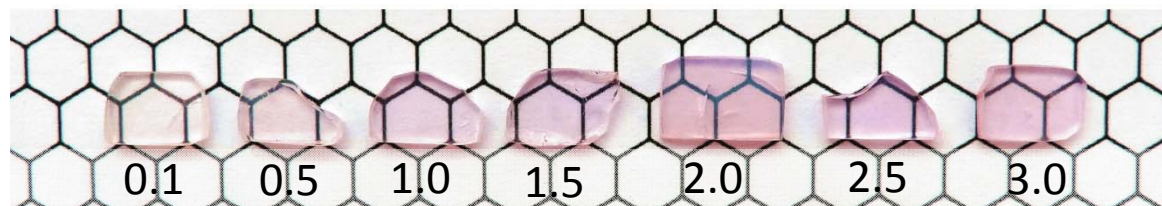
Upconversion luminescence



Upconversion luminescence

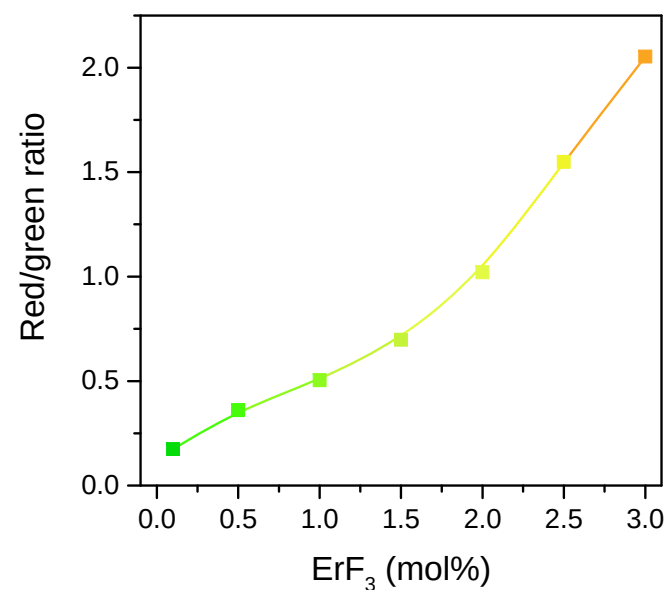
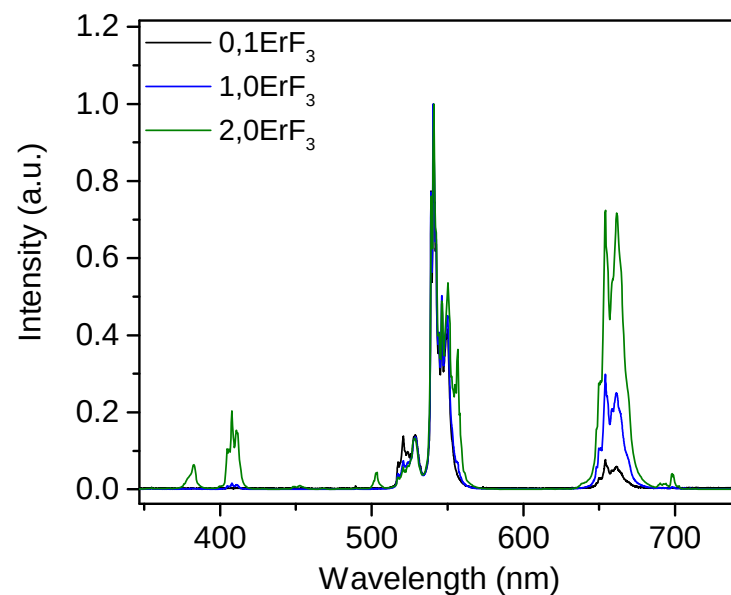


ErF₃ concentration

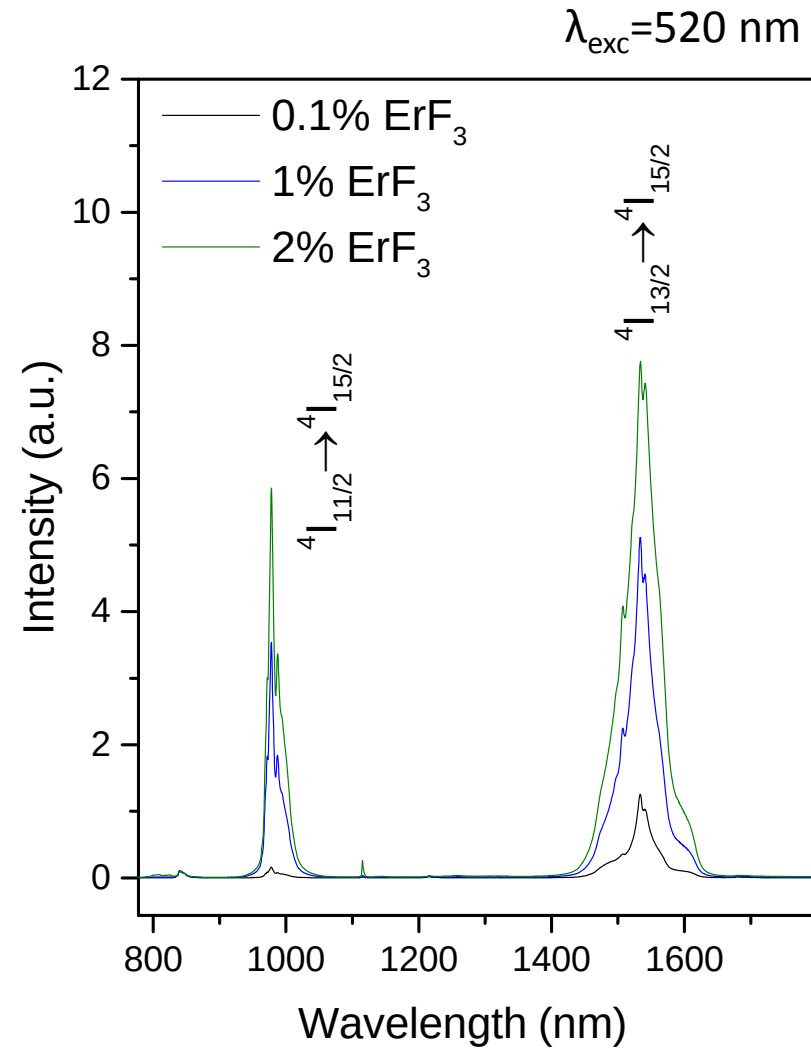
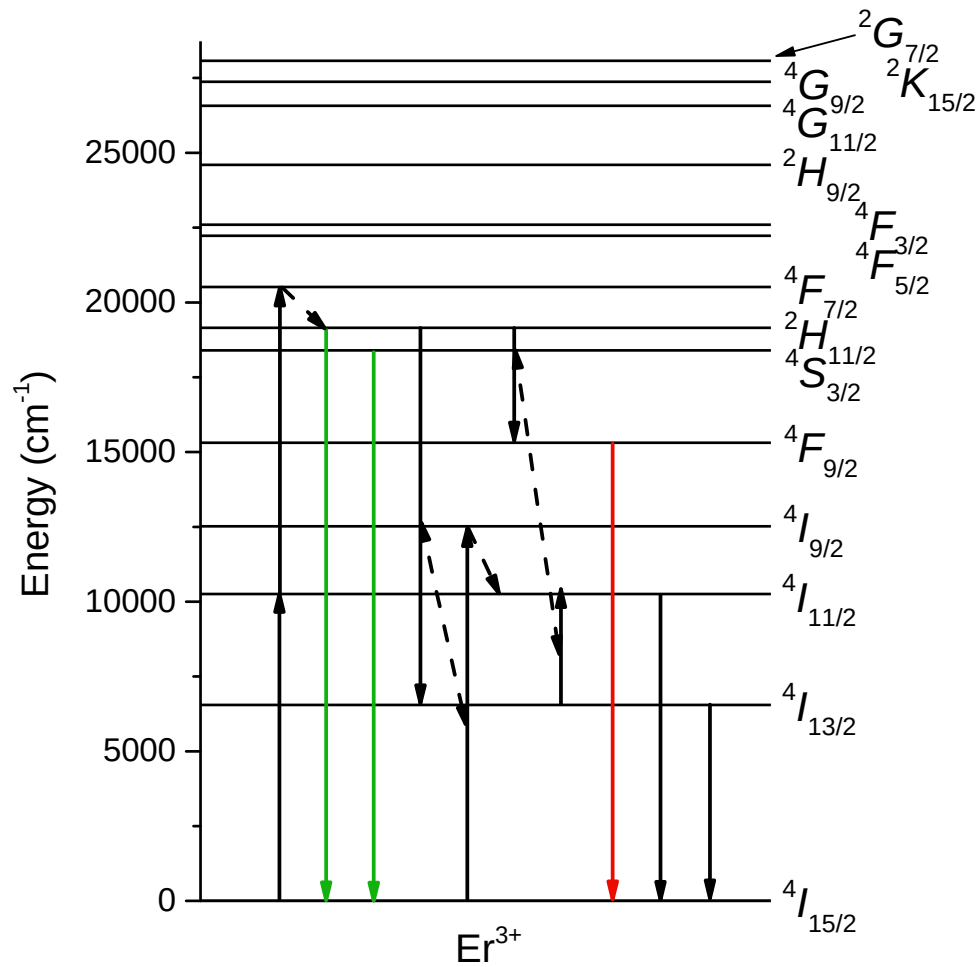


ErF₃ mol%

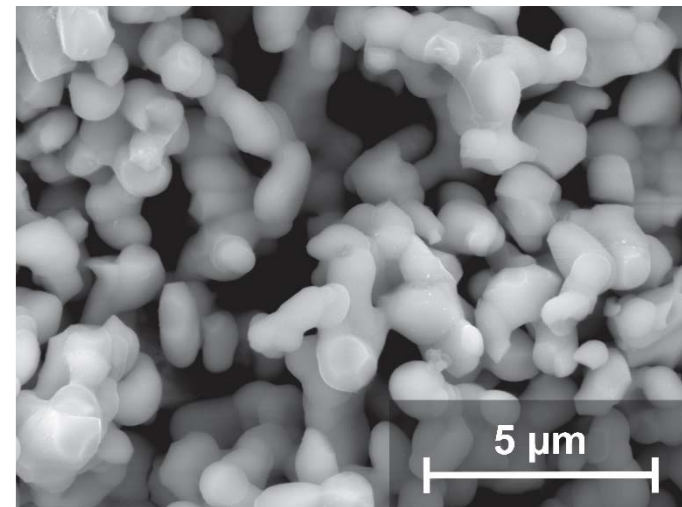
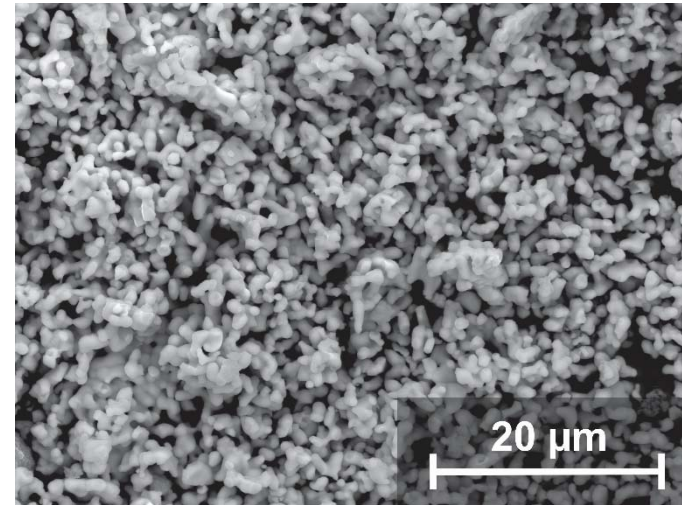
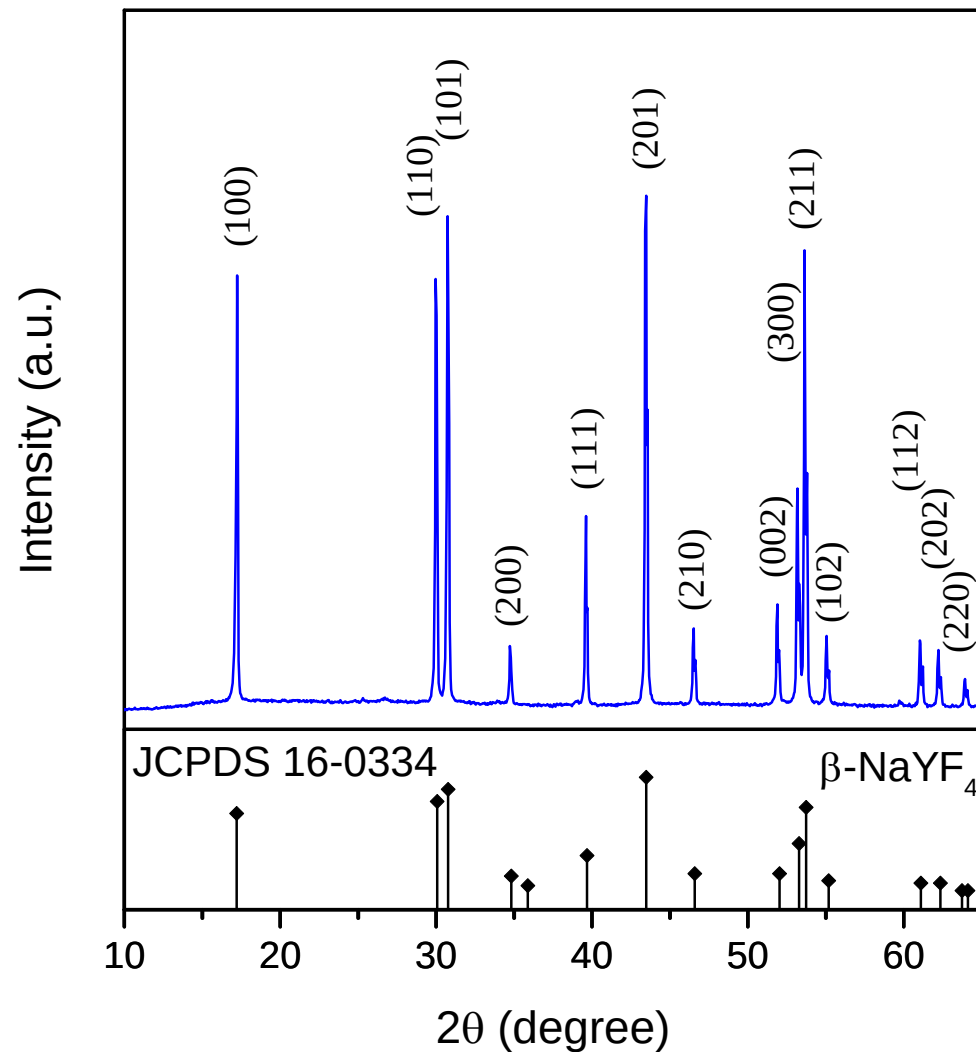
975 nm



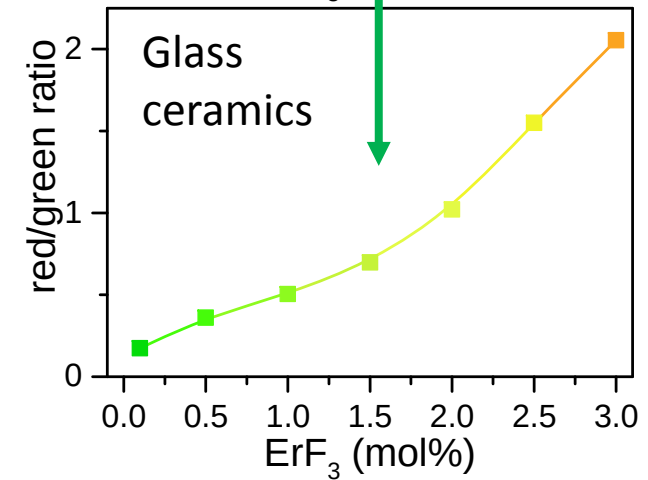
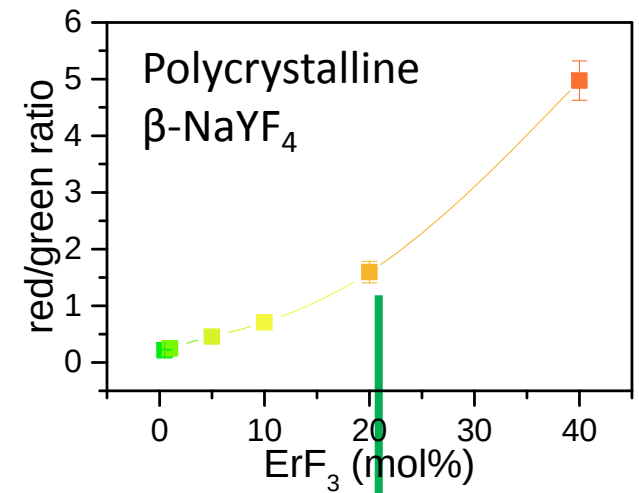
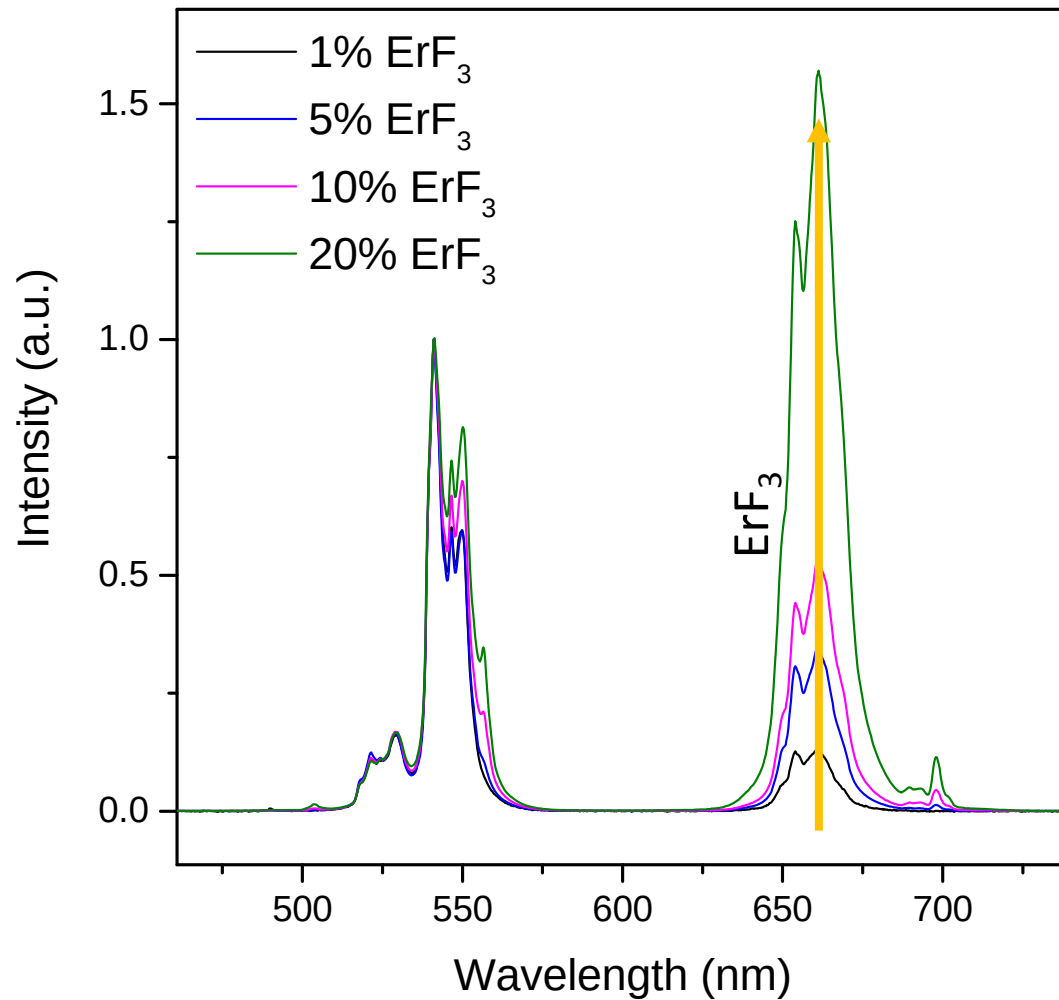
Cross-relaxation



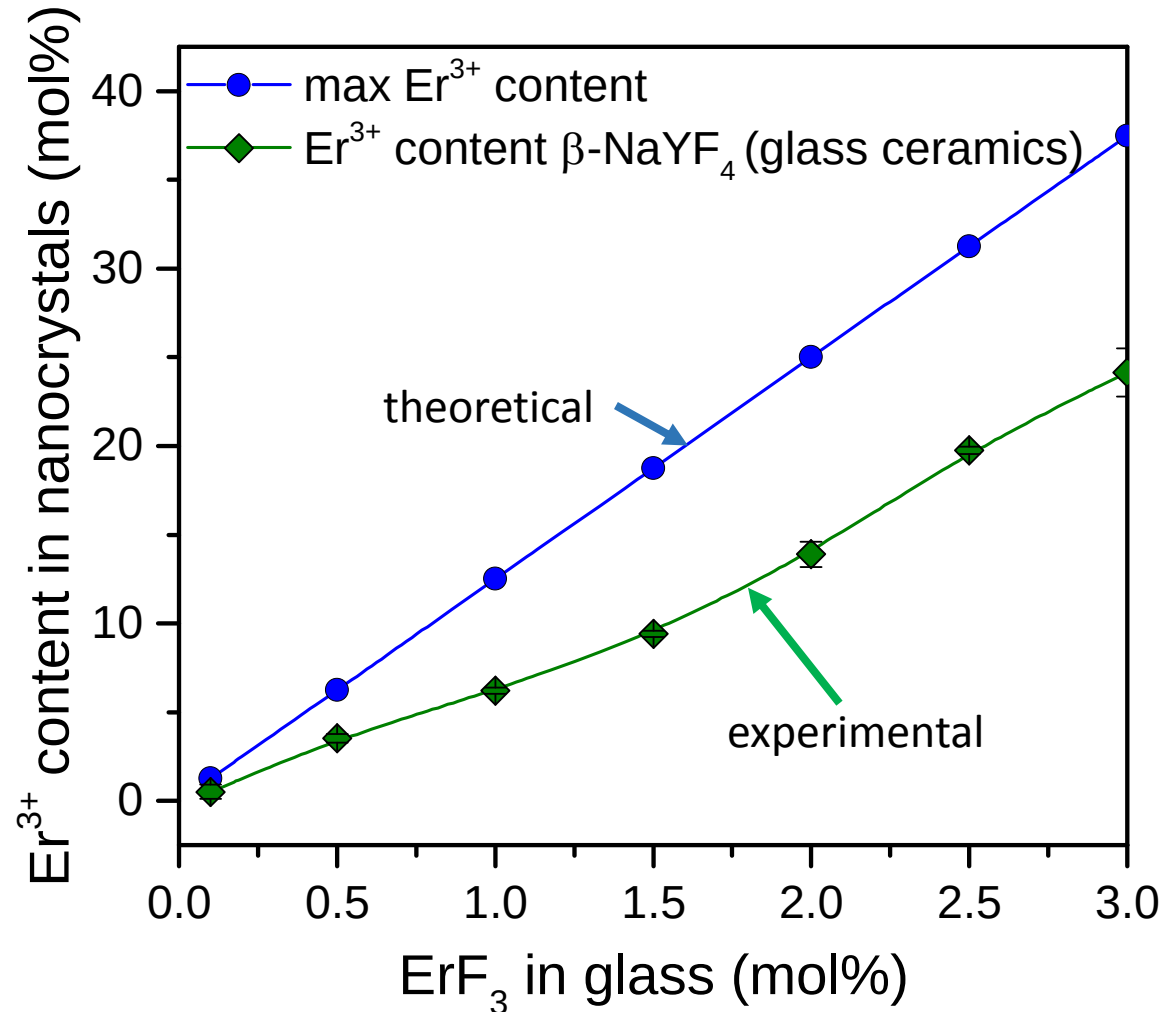
Microcrystalline β -NaYF₄:Er³⁺



Er³⁺ content in nanocrystals



Rare earth distribution



Conclusions

- New transparent erbium doped oxyfluoride glass ceramics containing hexagonal NaYF_4 nanocrystals has been prepared.
- The enhancement of the upconversion efficiency of glass ceramics is explained by the incorporation of Er^{3+} into low-phonon $\beta\text{-NaYF}_4$ crystalline phase.
- The Er^{3+} content in nanocrystals was estimated by comparing red/green luminescence intensity in glass ceramics with polycrystalline $\beta\text{-NaYF}_4\text{:Er}^{3+}$ to be more than 60%

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Transparent oxyfluoride glass ceramics as a scintillator material?

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Thank you for your attention!

