Phosphors Processing and their Properties the case of SrS:Ce

D. Kulesza[1], K. Fiączyk[1], A. Wiatrowska, E. Zych[1,2]

[1]Faculty of Chemistry, University of Wroclaw, 14. F. Joliot-Curie Street, 50-383 Wroclaw , Poland

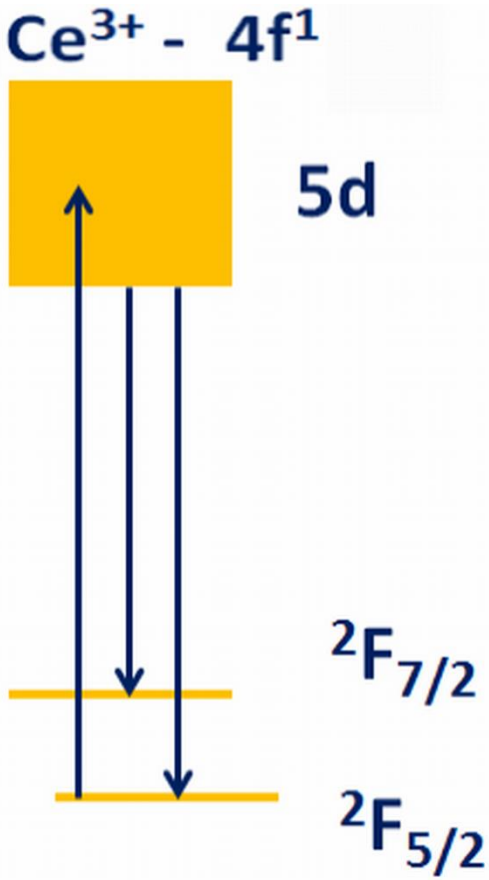
[2]Wrocław Research Centre EIT+, 147/149 Stabłowicka Street, 54-066 Wroclaw, Poland

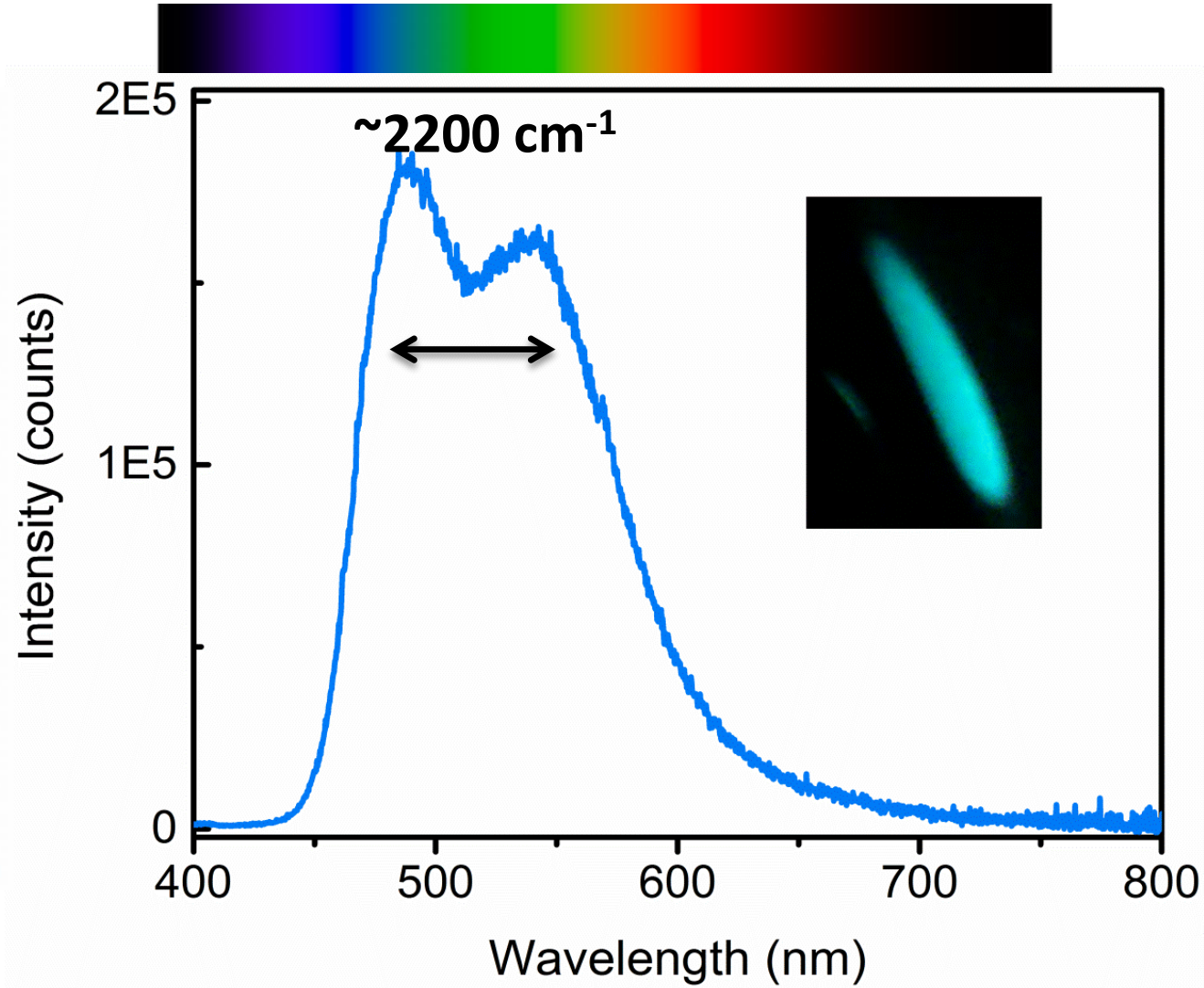
INNOVATIVE ECONOMY
NATIONAL COHESION STRATEGY

Uniwersytet Wrocławski

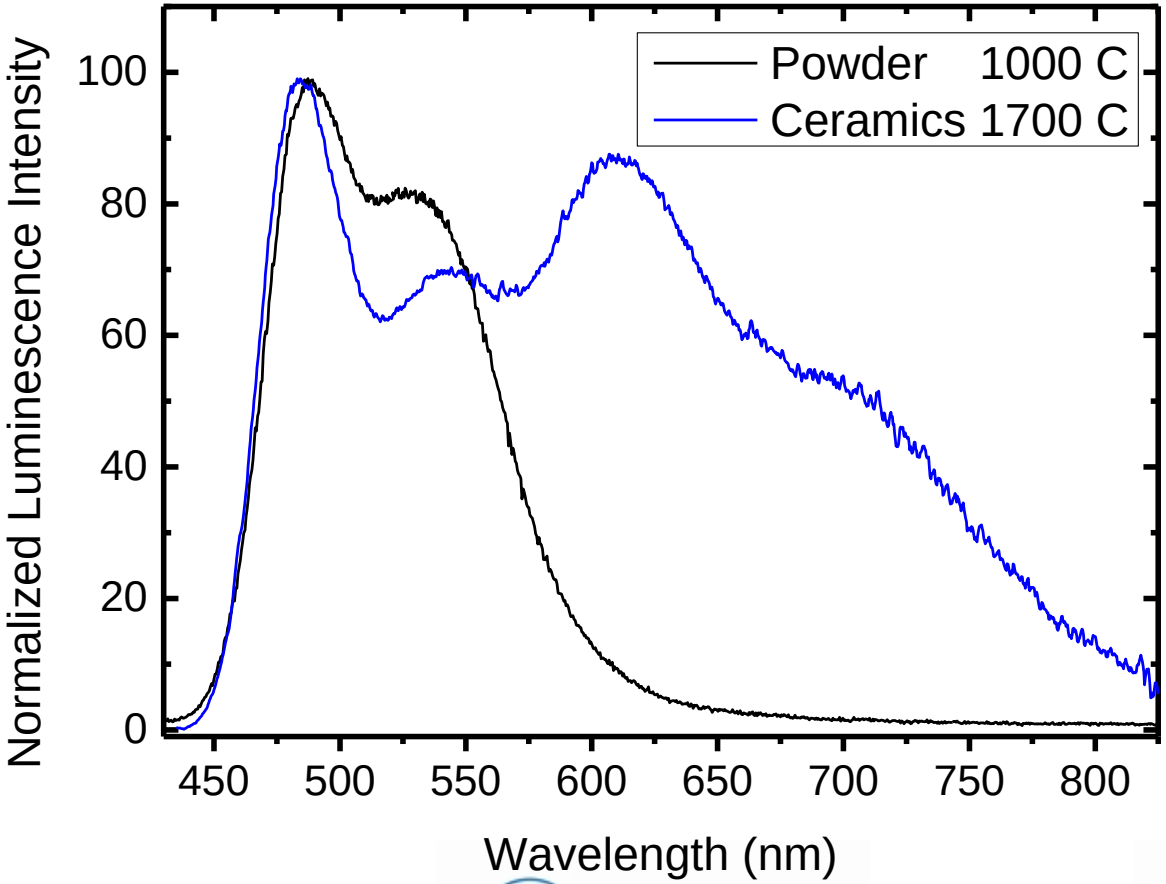
EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

Regular Luminescence of $SrS:Ce^{3+}$





A New PL of $SrS:Ce^{3+}$ Ceramics in Red (+IR)

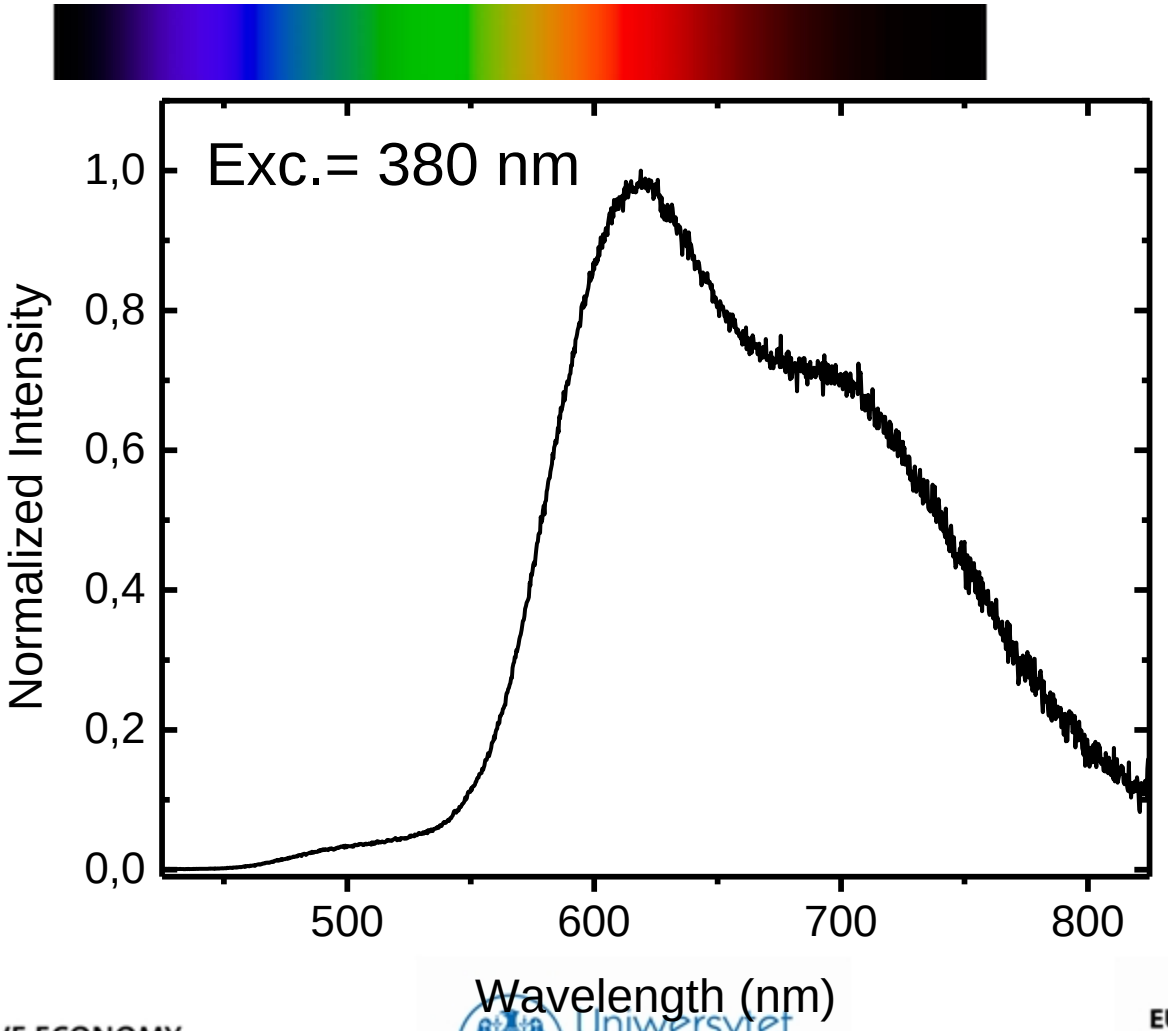


INNOVATIVE ECONOMY
NATIONAL COHESION STRATEGY

Uniwersytet Wrocławski

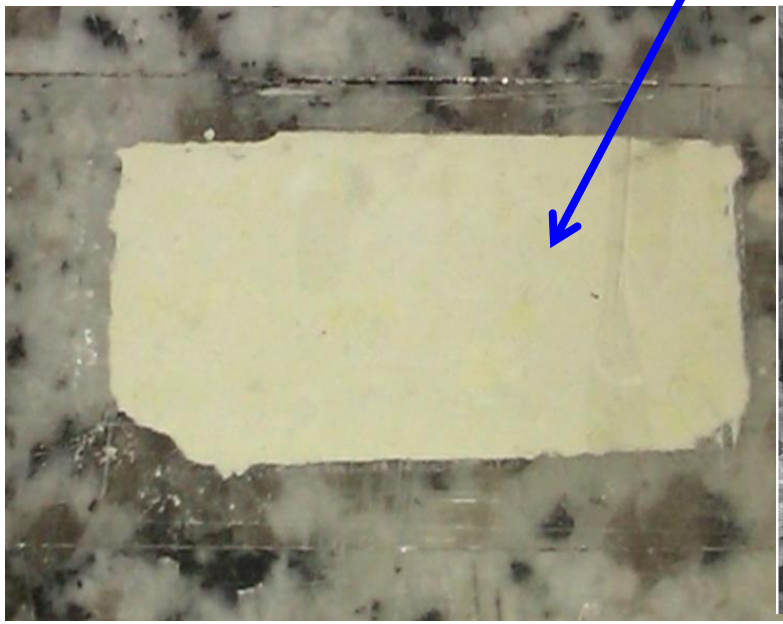
EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

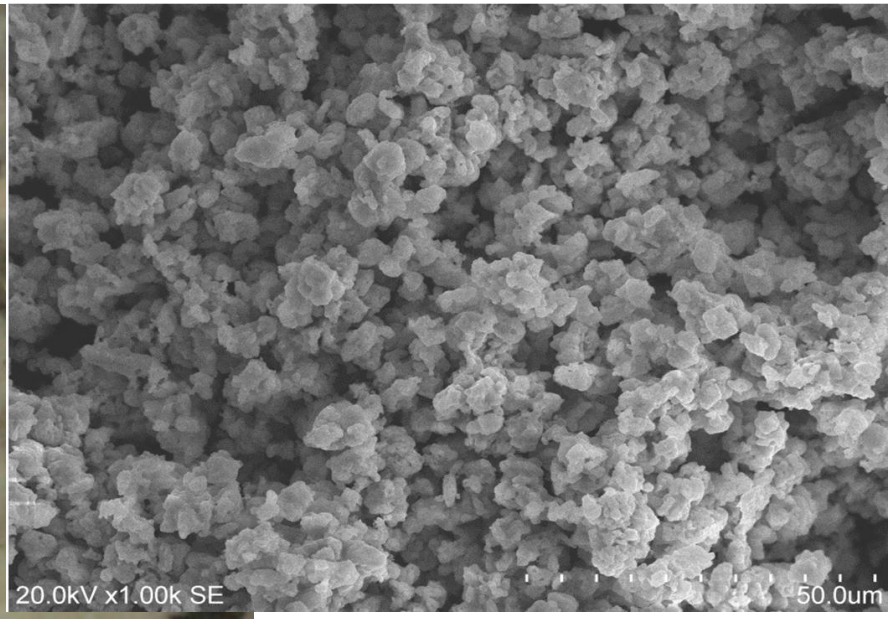
The Red (+IR) PL may be excited selectively



Synthesis of SrS:Ce

- $Sr^{2+} + SO_4^{2-} \rightarrow SrSO_4\downarrow$ ($SrSO_4$:Ce 0.05% and 0.5%)↓
- $SrSO_4$:Ce reduced to SrS:Ce (CO atmosphere, 1000 C)





INNOVATIVE ECONOMY
NATIONAL COHESION STRATEGY

Uniwersytet Wrocławski

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

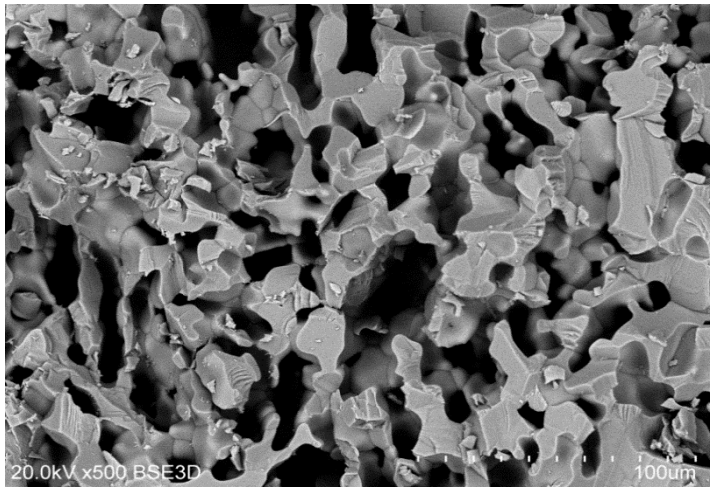
SrS:Ce Sintering

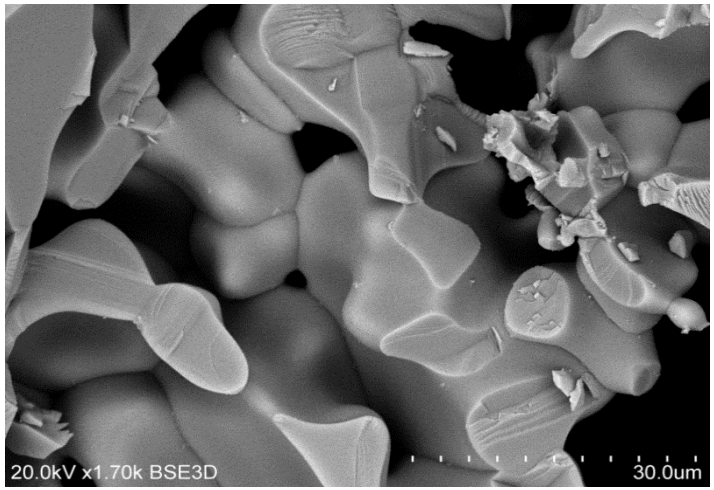
- Temperatures:

1000°C, **1400°C, 1500°C, 1600°C, 1700°C**

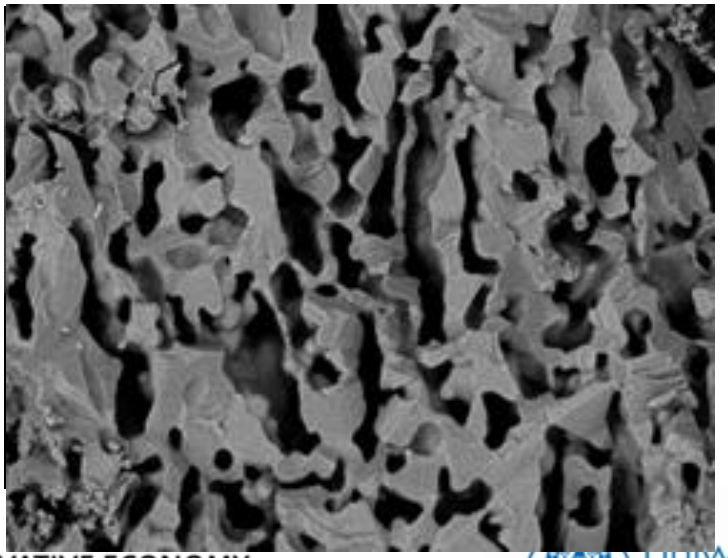
SINTERED CERAMICS - 1400/1500 °C

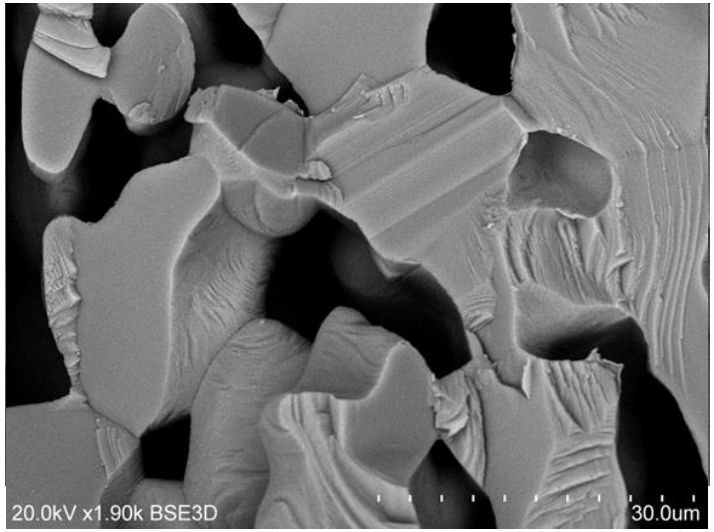
1400 °C





1500 °C





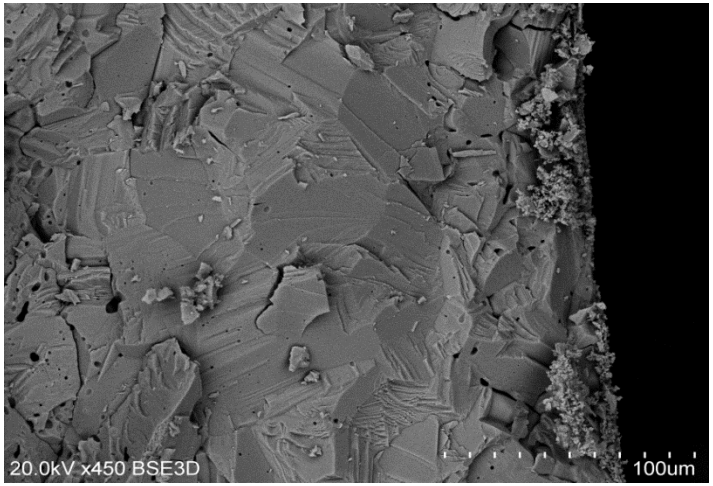
INNOVATIVE ECONOMY
NATIONAL COHESION STRATEGY

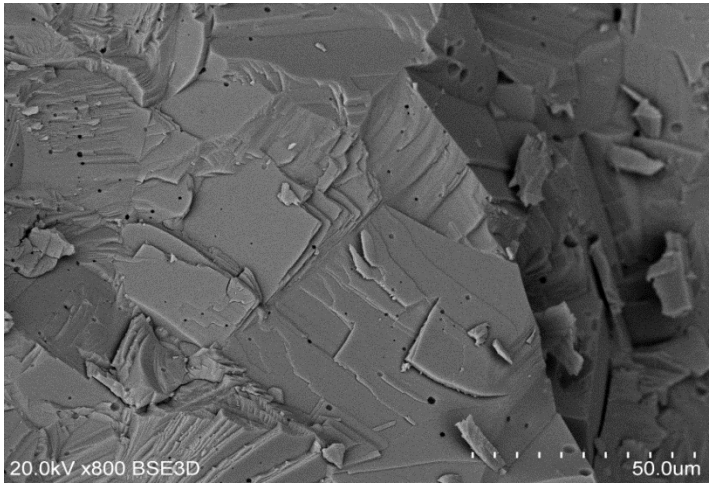
Uniwersytet Wrocławski

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

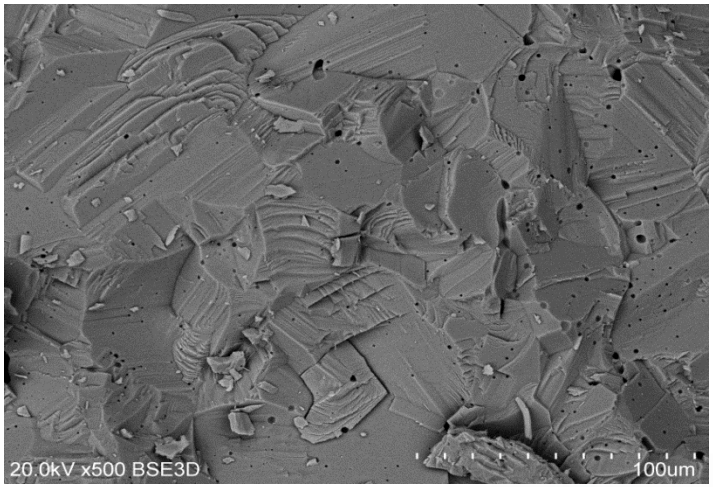
SINTERED CERAMICS - 1600/1700 °C

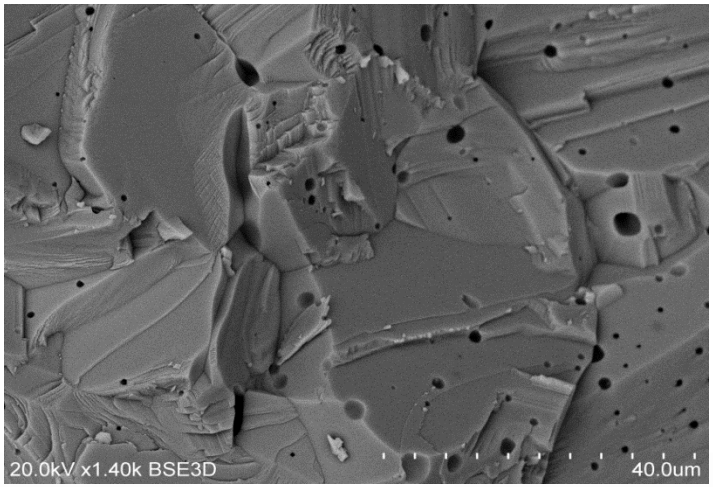
1600 °C





1700 °C





INNOVATIVE ECONOMY
NATIONAL COHESION STRATEGY

Uniwersytet Wrocławski

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

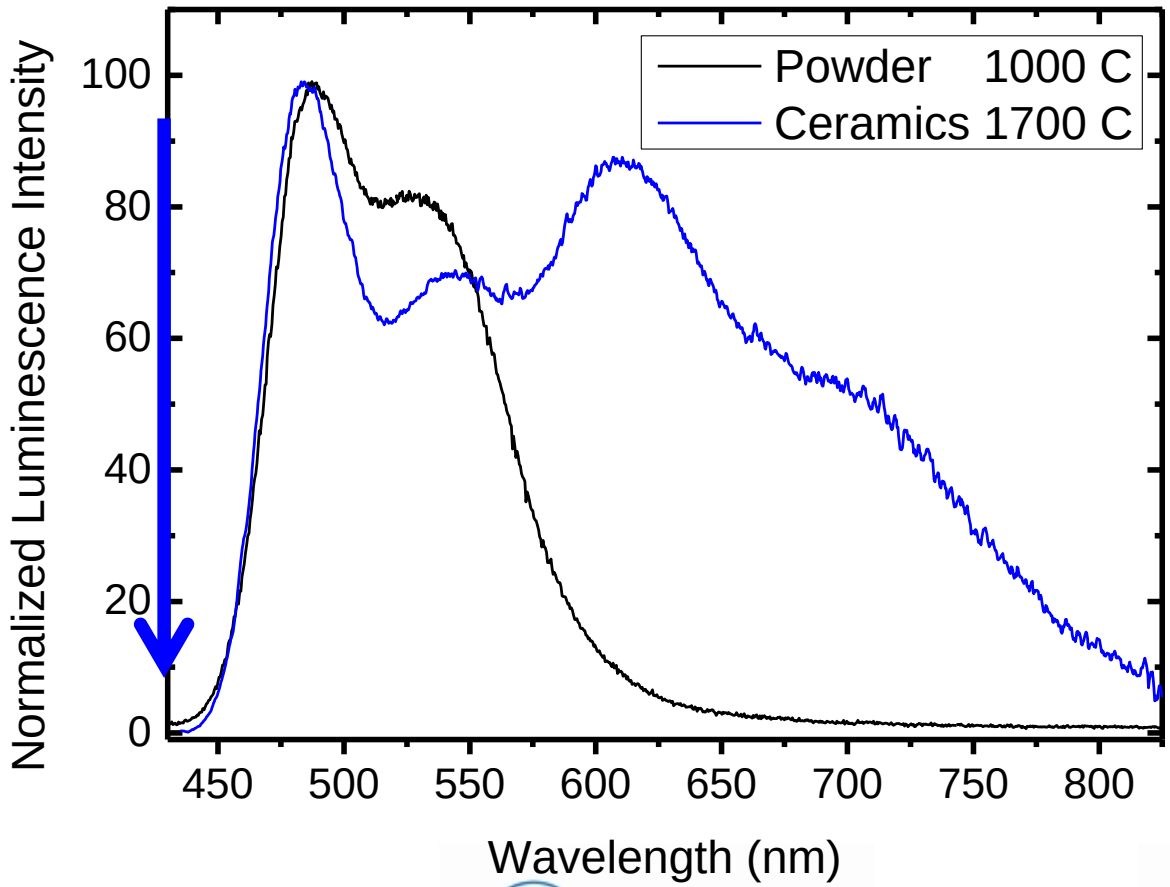
Spectroscopic Properties of the Sintered SrS:Ce

INNOVATIVE ECONOMY
NATIONAL COHESION STRATEGY

Uniwersytet Wrocławski

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

A New PL of $SrS:Ce^{3+}$ Ceramics in Red (+IR)

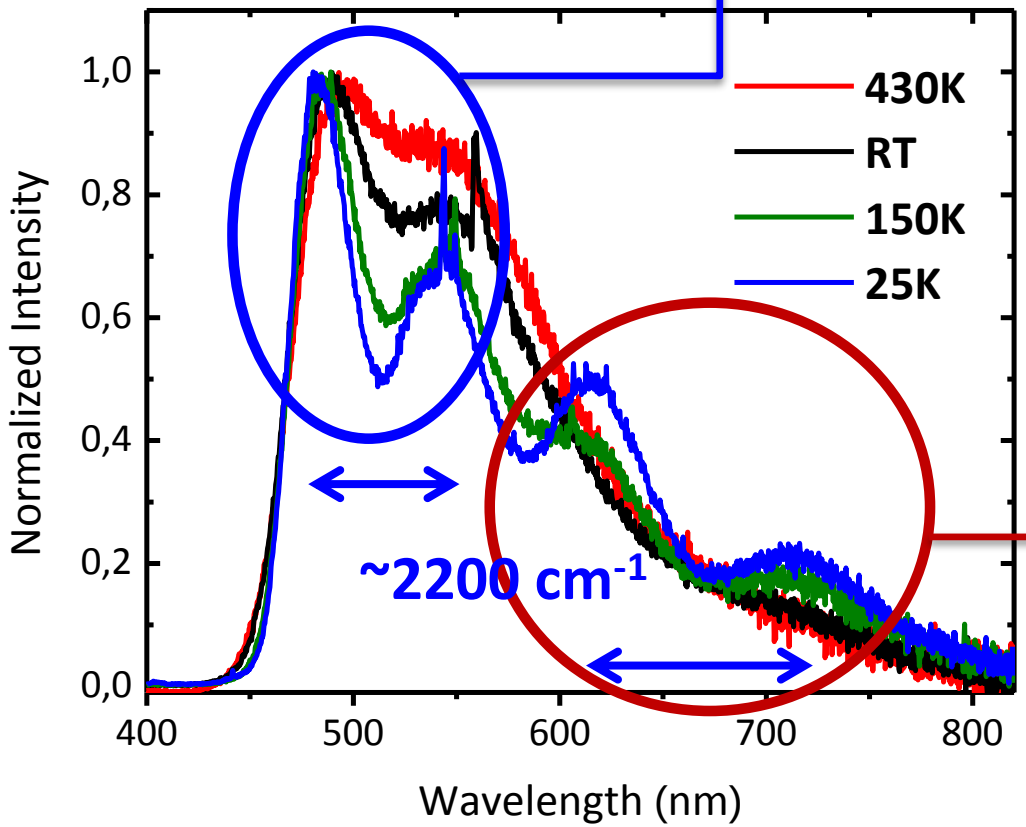


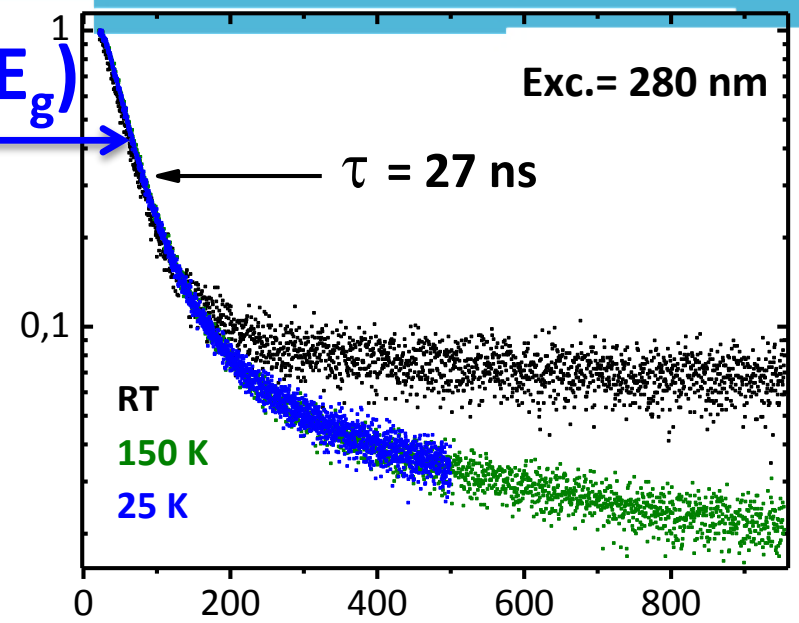
INNOVATIVE ECONOMY
NATIONAL COHESION STRATEGY

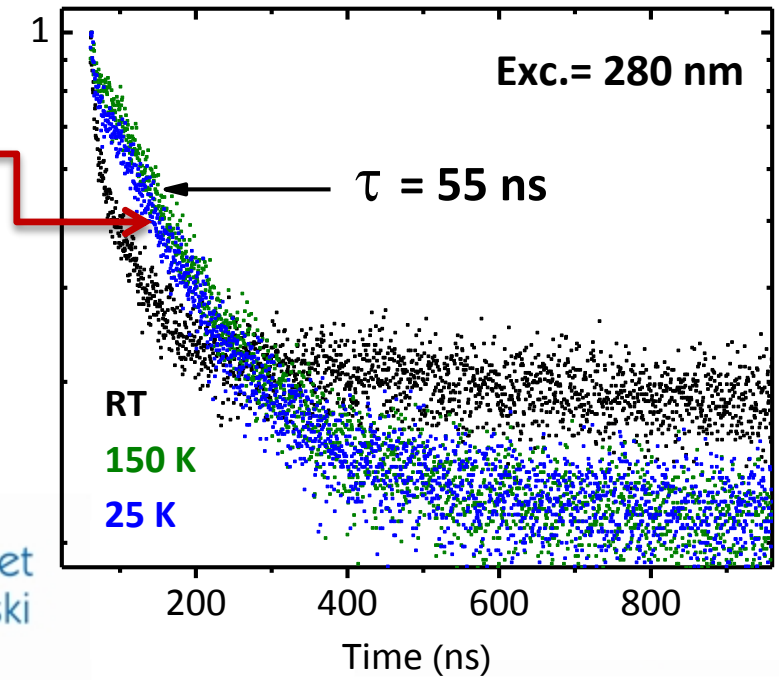
Uniwersytet Wrocławski

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

0.05%Ce, PL - Exc.= 280 nm (~E_g)



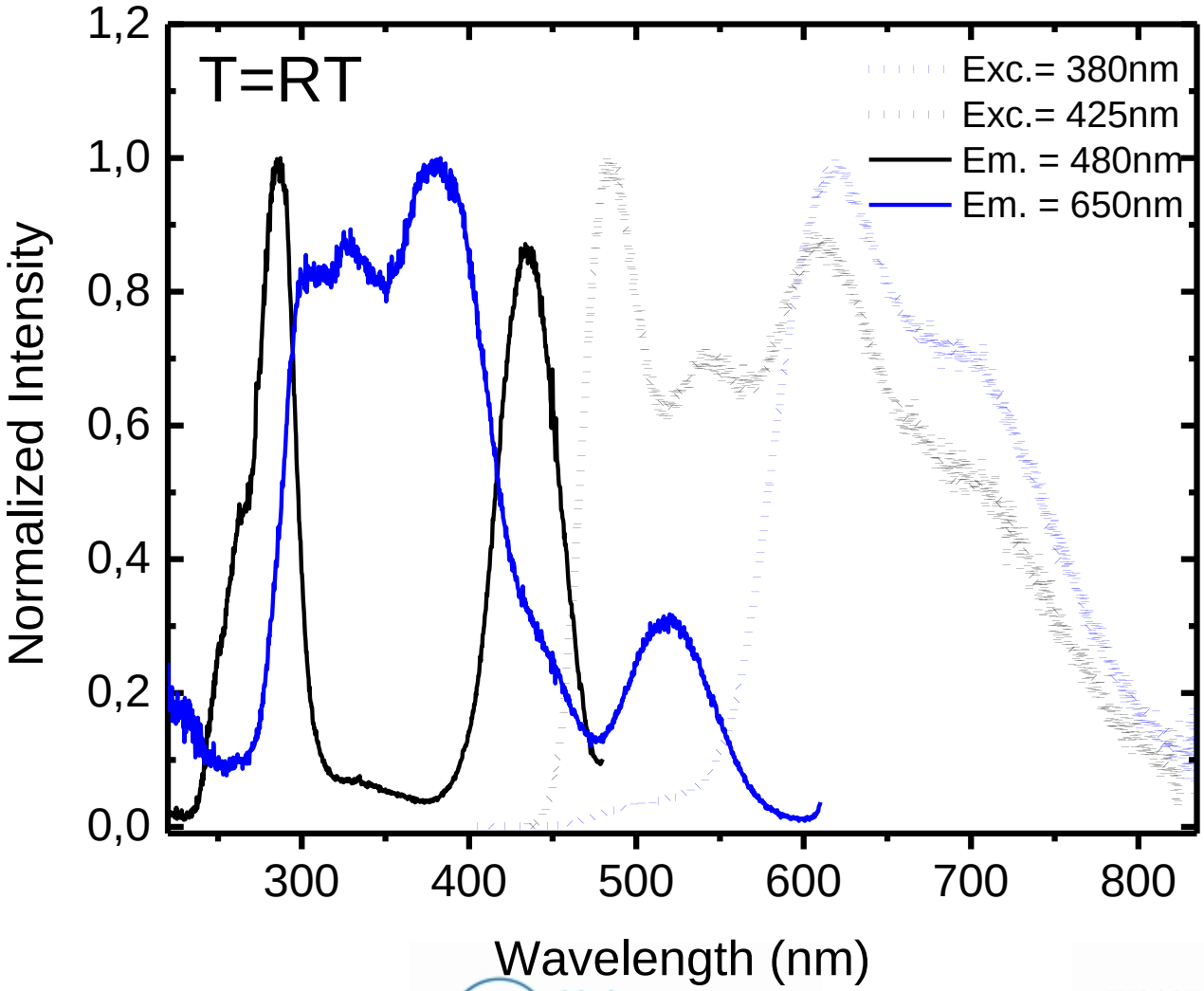




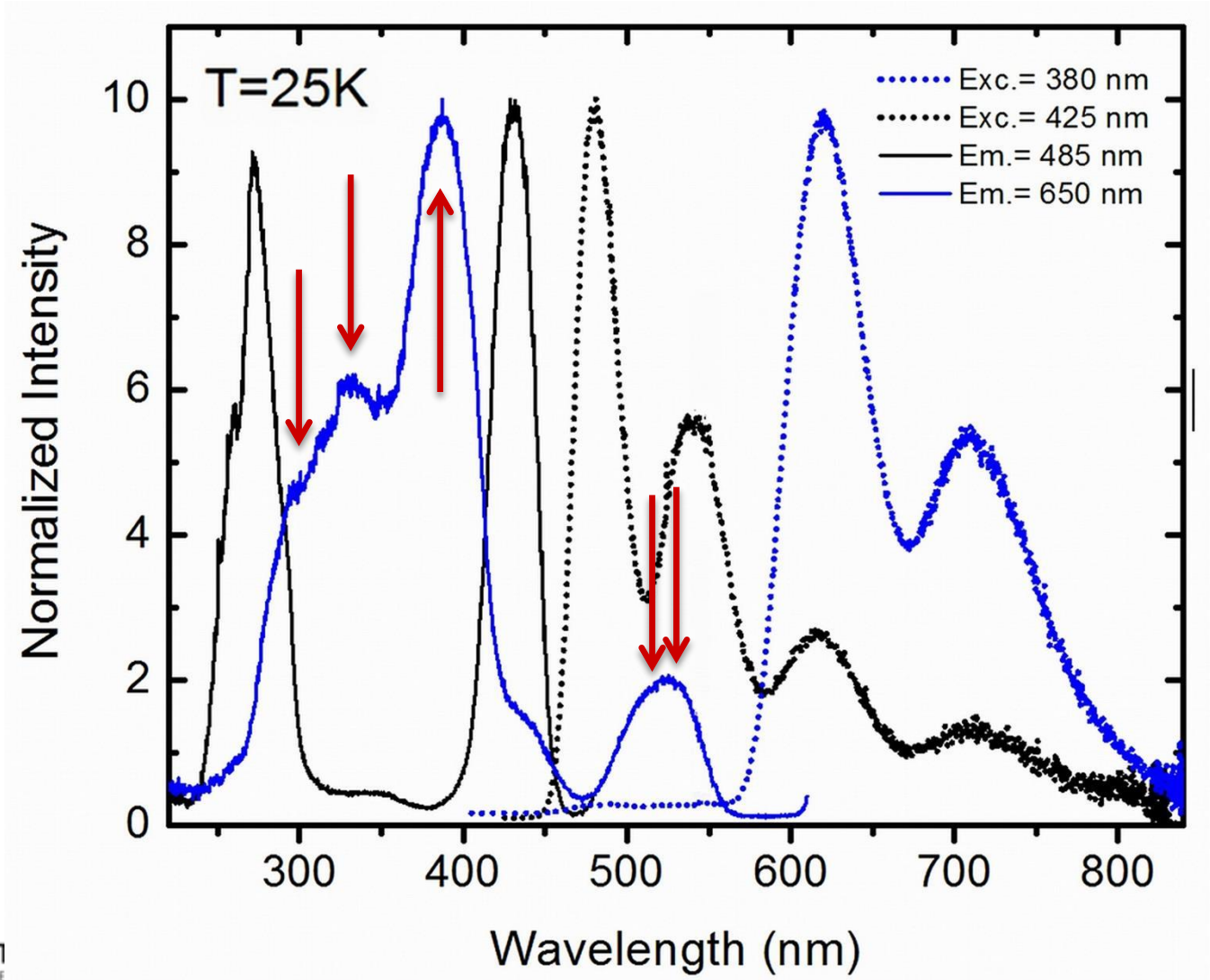
INNOVATIVE ECONOMY
NATIONAL COHESION STRATEGY

Uniwersytet Wrocławski

0.05%Ce, Different Emitting Centers - RT



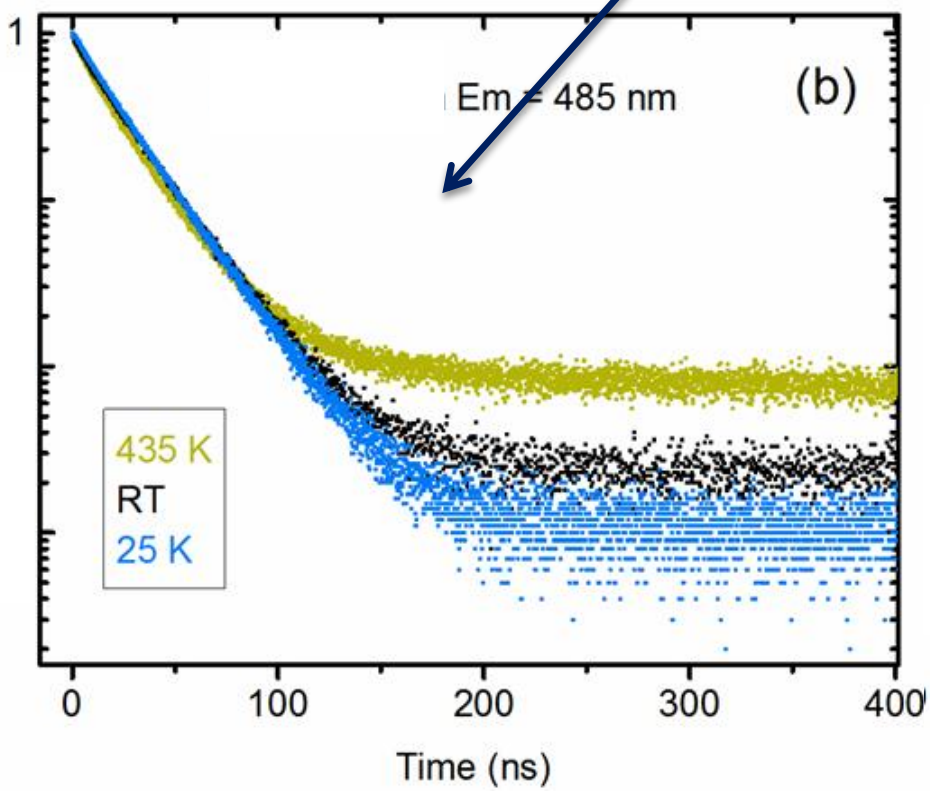
0.05%Ce, Different Emitting Centers - 25 K

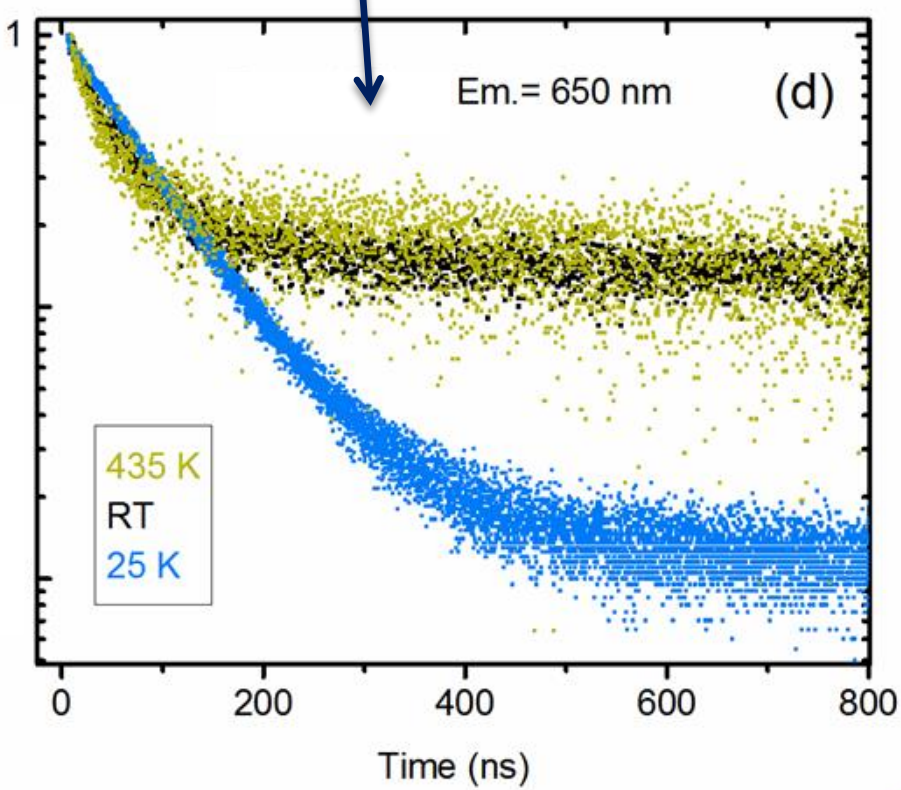


The new center has low symmetry

as all 5d orbitals of Ce^{3+} have different energies

No energy tranfer between the two centers
Decays of the regular and the irregular emissions





Upon the properties of the new emitting center we propose that it cosist of clusters:

$[Ce^{3+}\text{-}S^{2-}\text{-}Ce^{3+}]$

↑

Interstitial S^{2-}

balancing the extra charge

of two Ce^{3+}

The clustering occurs only upon high-temperature sintering as then an efficient mass transfer allows the defect ions to migrate for distances long enough to form such complex structures.

Interstitail S^{2-} lowers the local symmetry of Ce3+ engaged into formation of the

$$[Ce^{3+}\text{-}S^{2-}\text{-}Ce^{3+}]$$

Conclusions

- High-temperature sintering (1700 °C) of SrS:Ce leads to a new red-IR Ce^{3+} emission band
- Both centers have much different excitation spectra (site-selective excitation possible)
- The red-emitting Ce^{3+} has much lower local symmetry than the regular one
- There is no energy tranfer between the regular and the irregular (red) Ce^{3+} centers

INNOVATIVE ECONOMY
NATIONAL COHESION STRATEGY

Uniwersytet Wrocławski

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

Thank You

and

This work was supported by POIG.01.01.02-02-006/09 project co-funded by **European Regional Development Fund** within the Innovative Economy Program.
Priority I, Activity 1.1. Sub-activity 1.1.2, which is gratefully acknowledged.

INNOVATIVE ECONOMY
NATIONAL COHESION STRATEGY

Uniwersytet Wrocławski

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND