Action MP1401

RE co-doped germanate optical fibers for source application

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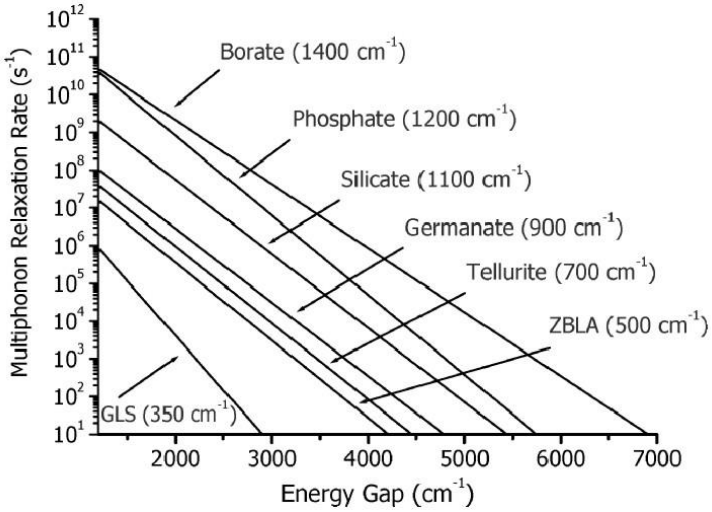
POLISH ROADMAPS FOR RESEARCH INFRASTRUCTURES

Action MP1401

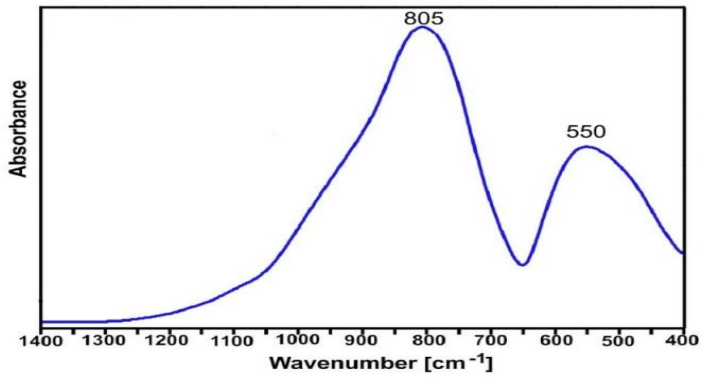
Outline

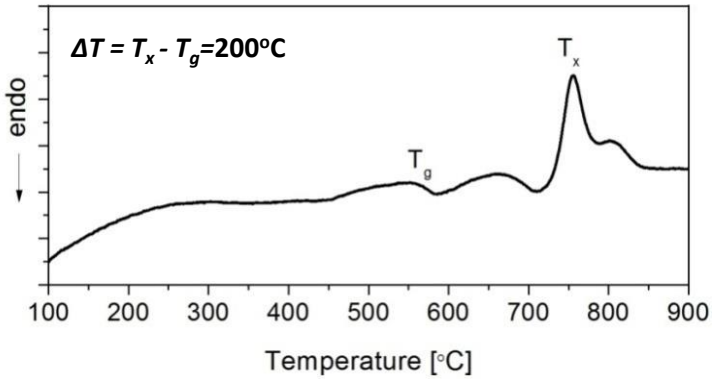
- Motivation –multicomponent optical fibers – ASE broadband emission
- Constructions of co-doped germanate optical fibers – luminescent properties, @VIS, @ 2μm
- Conclusions and perspectives

Germano-gallate glass host



Parameter	Value
Refractive index n (633nm)	1.691
Mass density ρ [g/cm^3]	4.42
Transformation temperature T_g [°C] (DSC)	555
Crystallization temperature T_x [°C] (DSC)	755
Maximum of phonon energy $h\omega_{max}$ [cm^{-1}]	805

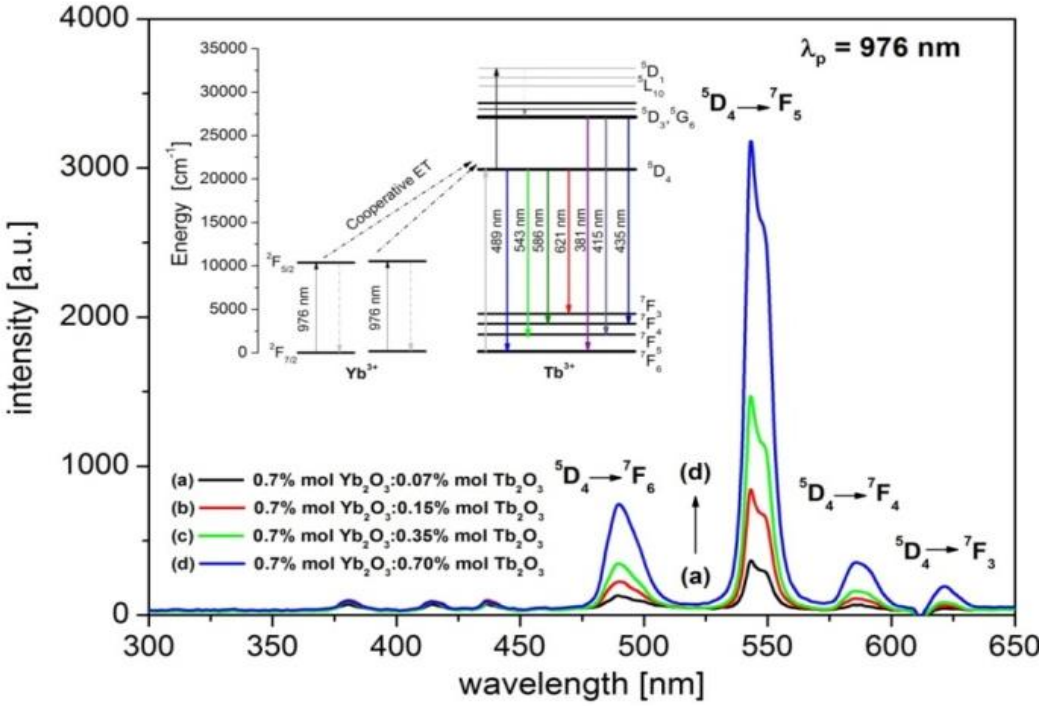


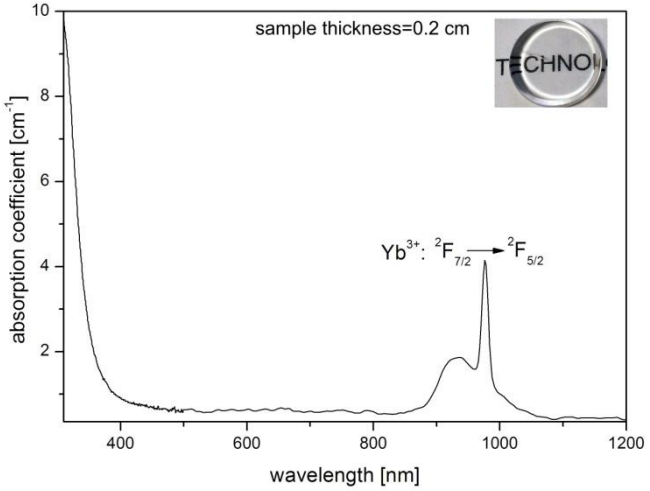


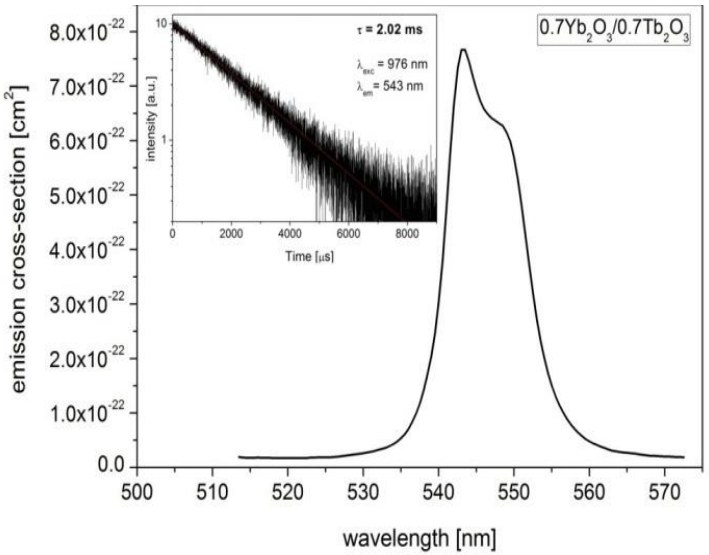
- 800 – 900 cm^{-1} corresponds to asymmetric stretching motions of GeO_4 tetrahedra containing bridging Ge-O(Ge) and non-bridging Ge-O$^-$oxygens
- 550cm^{-1} mixed stretching-bending motions

C. B. Layne, W. H. Lowdermilk, and M. J. Weber
Phys. Rev. B **16**, 10 – Published 1 July 1977

Luminescence of GeO_2 Yb^{3+}/Tb^{3+} glass



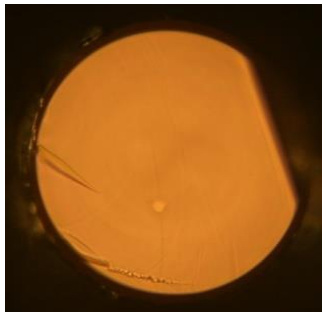




Content of Tb_2O_3	Lifetime Yb^{3+}:$^2F_{5/2}$ [μs]	ET efficiency [%]
0	882	0
0.15	839	4.87
0.35	821	6.91
0.7	**768**	**12.92**

Luminescence of GeO_2 Yb^{3+}/Tb^{3+} fiber

- outer cladding diameter=390 µm
- core diameter=10 µm
- $NA_{cladding}$=0.58
- NA_{core}=0.4
- Attenuation =2.9dB/m



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Analysis of upconversion luminescence in germanate glass and optical fiber codoped with Yb^{3+}/Tb^{3+}

M. Kochanowicz,[1,*] J. Zmojda,[1] P. Miluski,[1] M. Sitarz,[2] J. Pisarska,[3] W. A. Pisarski,[3] and D. Dorosz[1]

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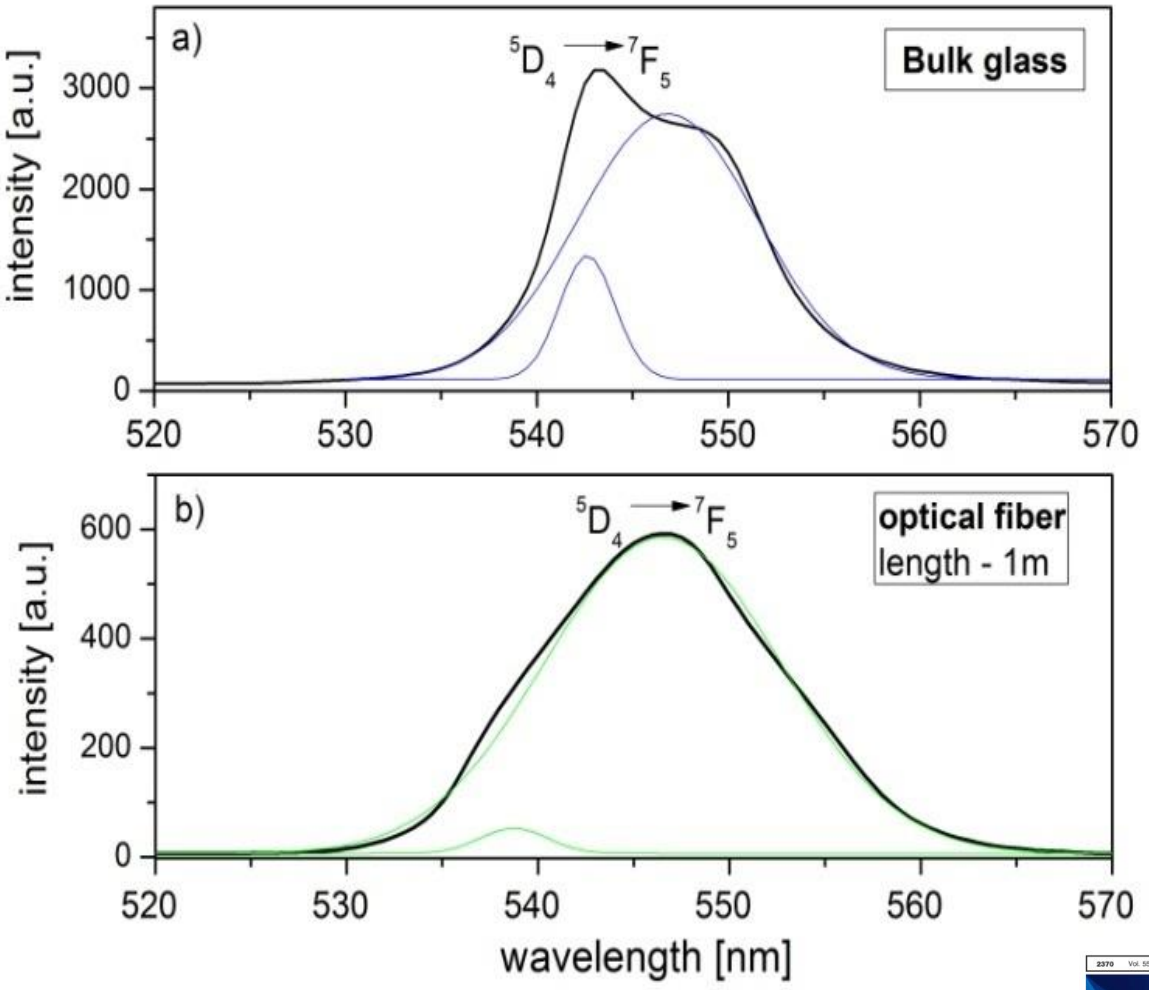

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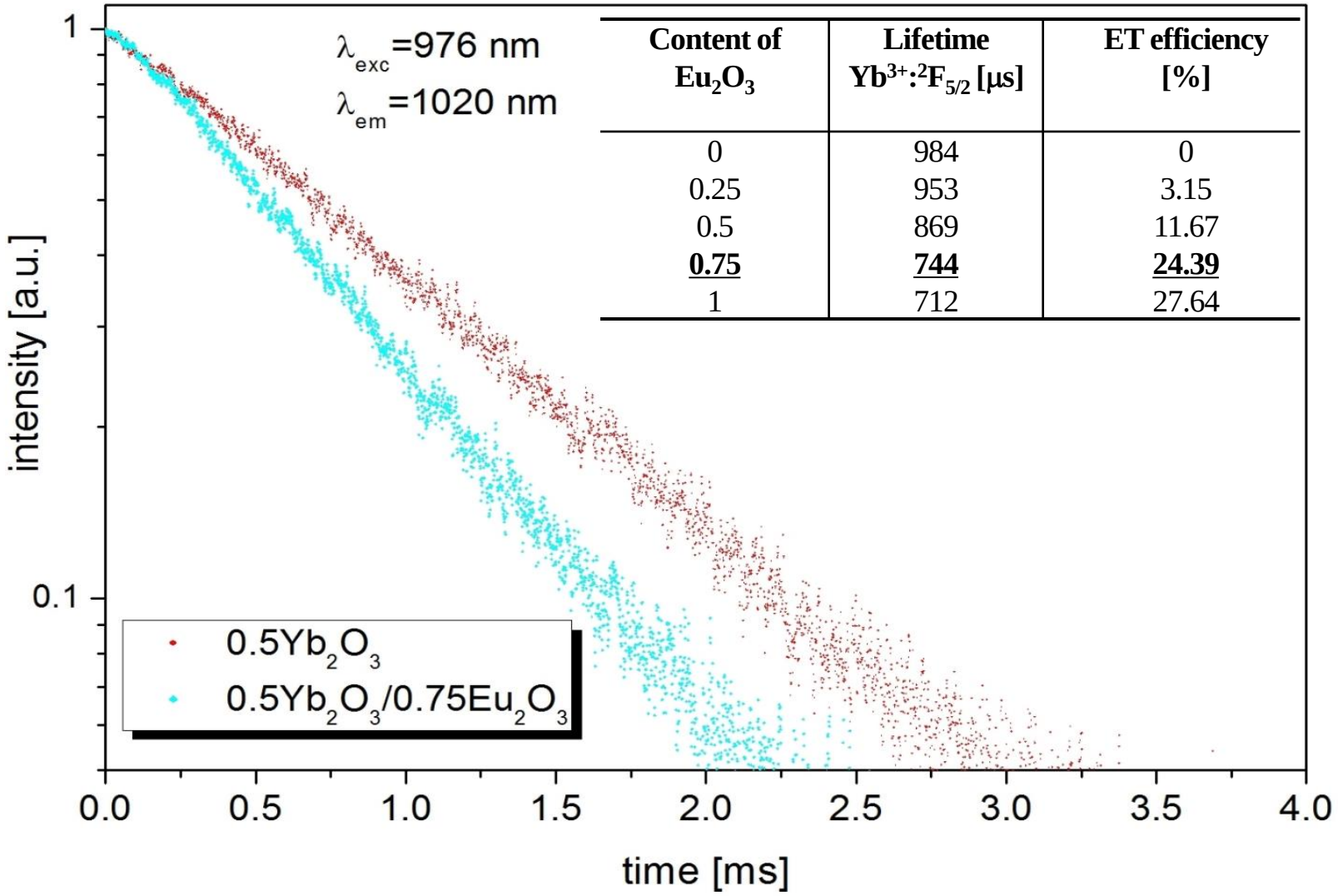
Luminescence of GeO_2

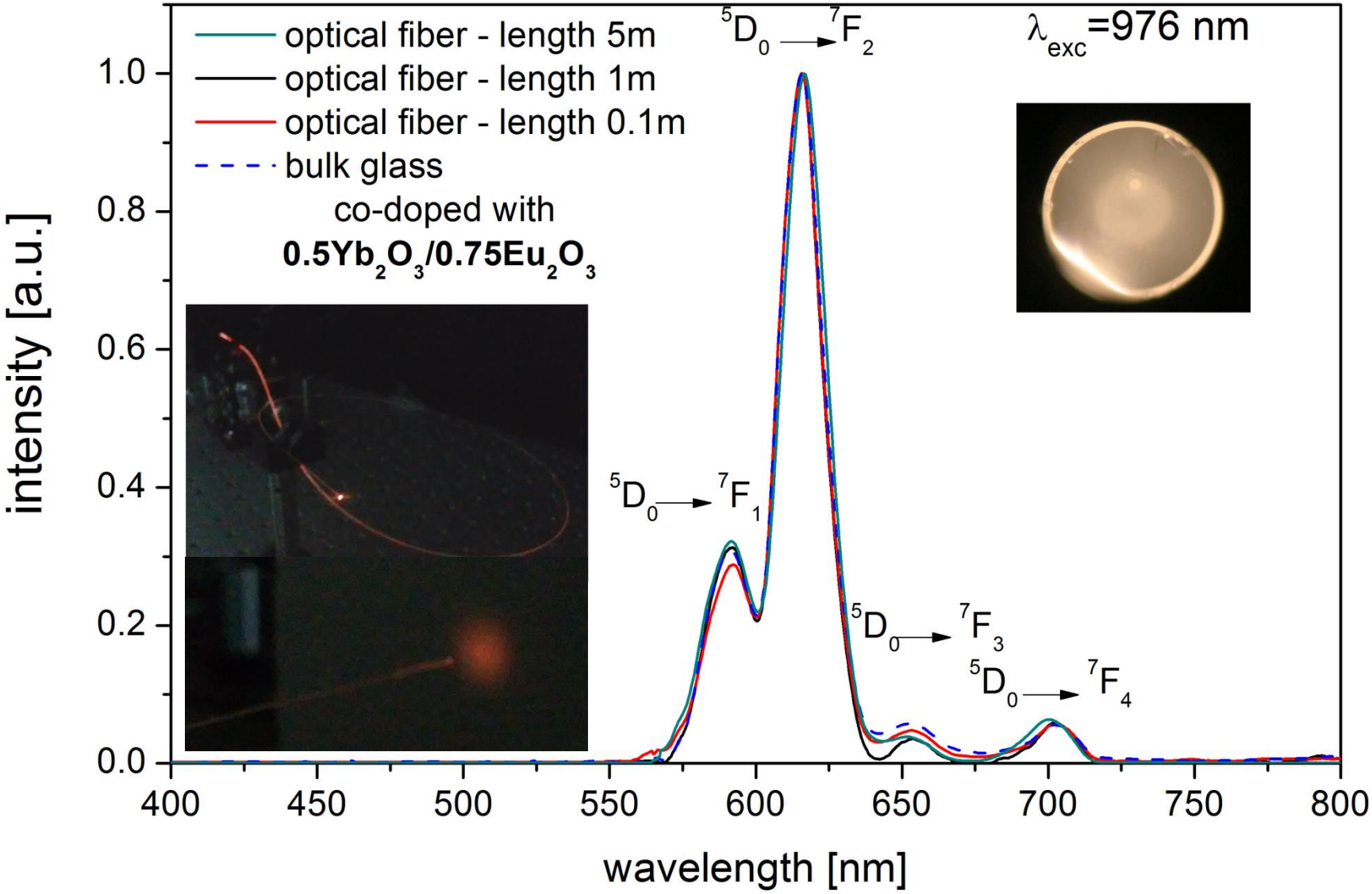
Yb^{3+}/Eu^{3+} double – clad optical fiber

Luminescence of GeO_2 Yb^{3+}/Eu^{3+} fiber

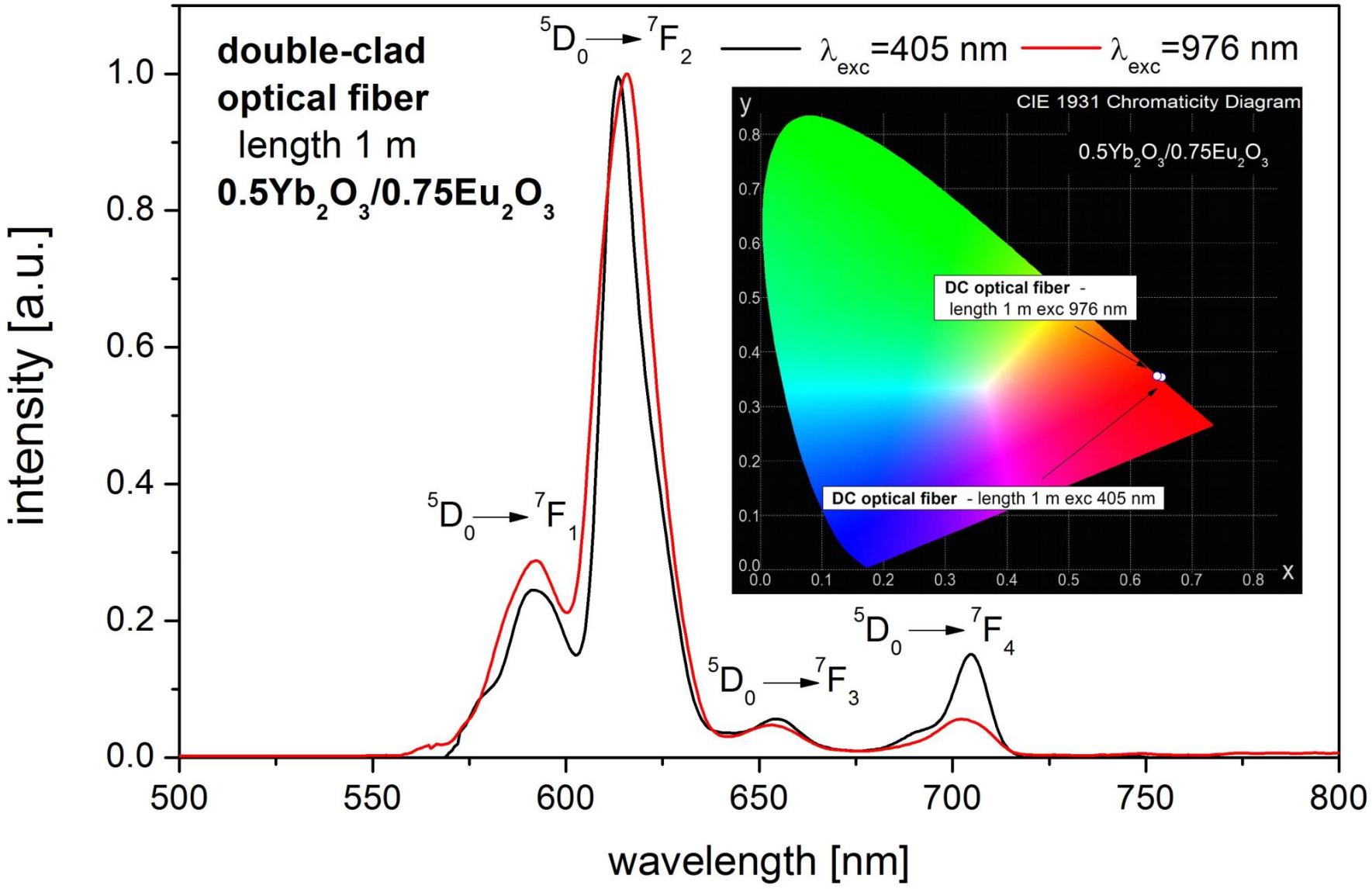


Content of Eu_2O_3	Lifetime Yb^{3+}:$^2F_{5/2}$ [μs]	ET efficiency [%]
0	984	0
0.25	953	3.15
0.5	869	11.67
0.75	**744**	**24.39**
1	712	27.64

Luminescence of GeO_2 Yb^{3+}/Eu^{3+} fiber



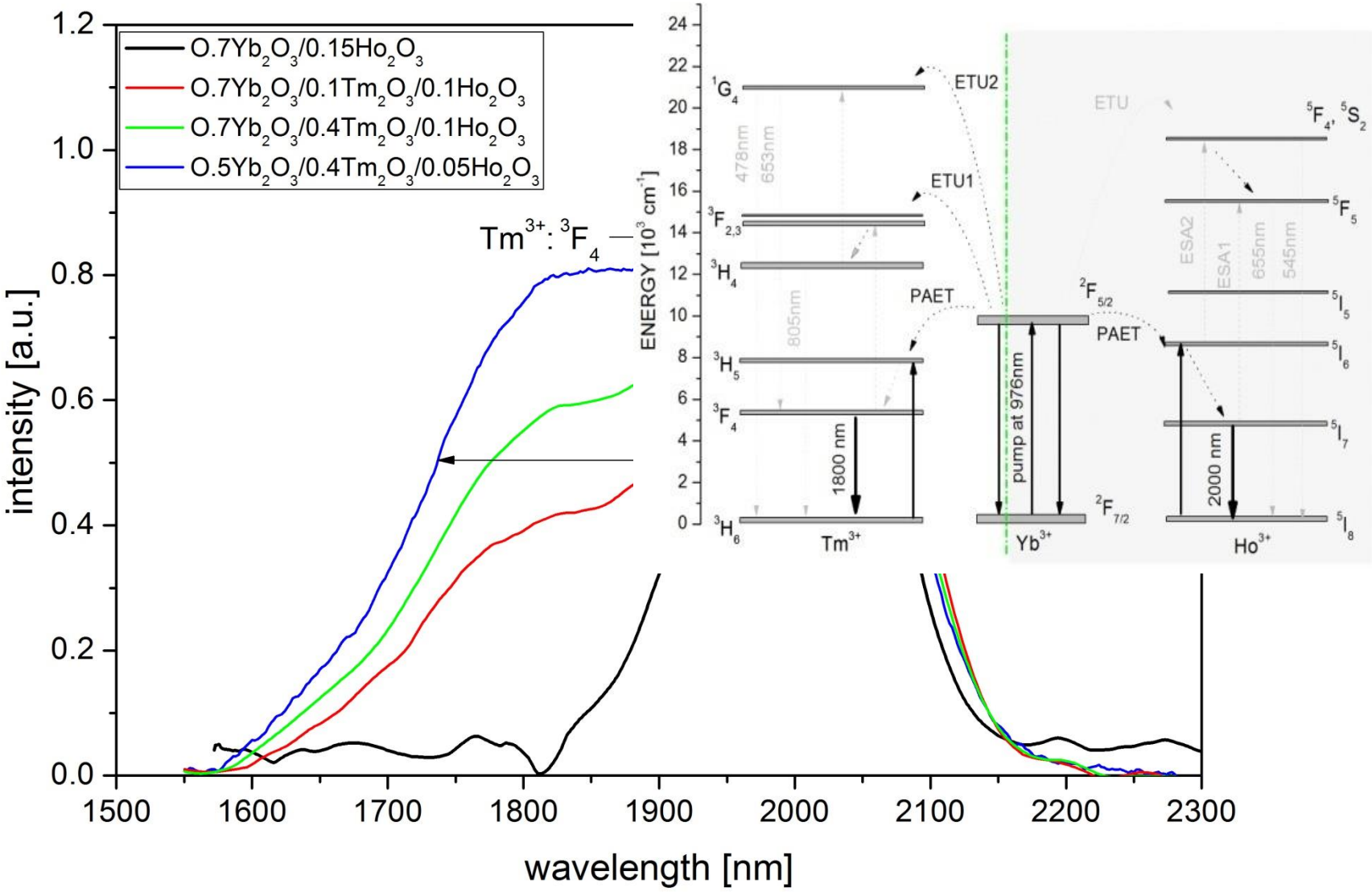
Luminescence of GeO_2 Yb^{3+}/Eu^{3+} fiber



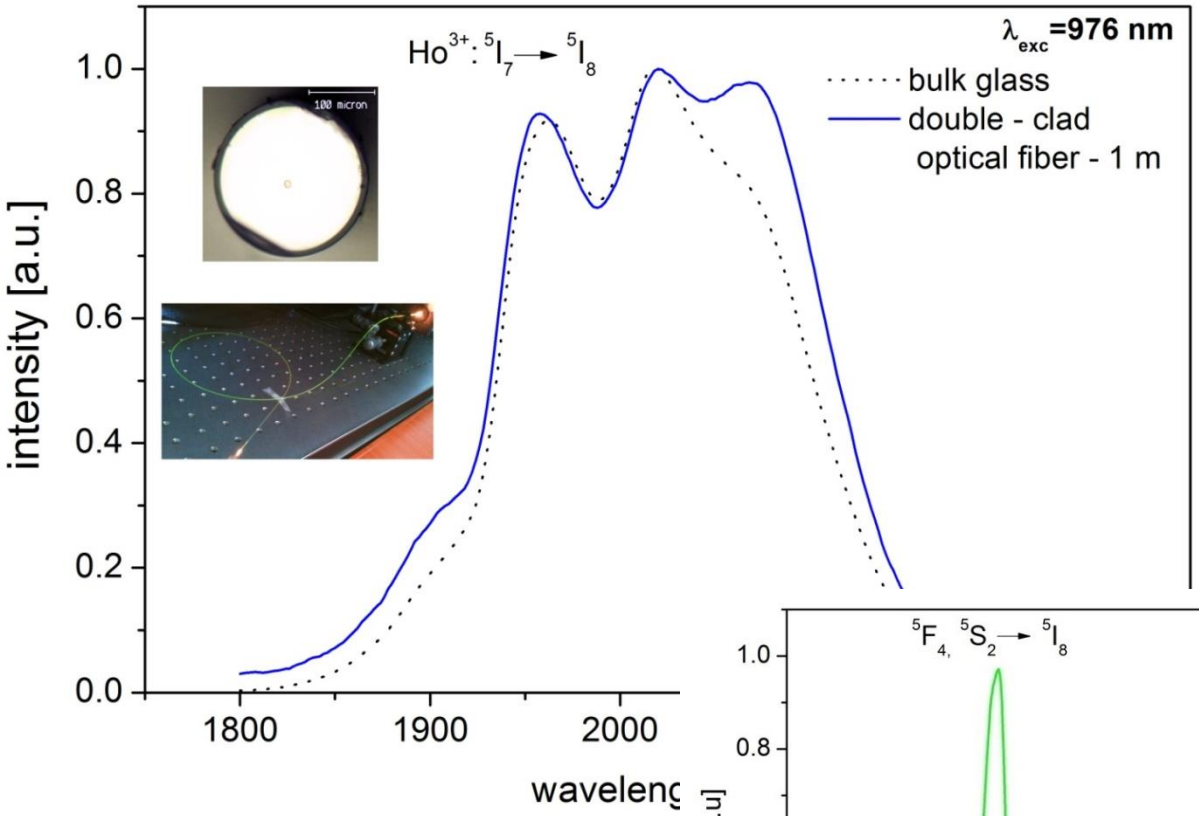
Luminescence of GeO_2

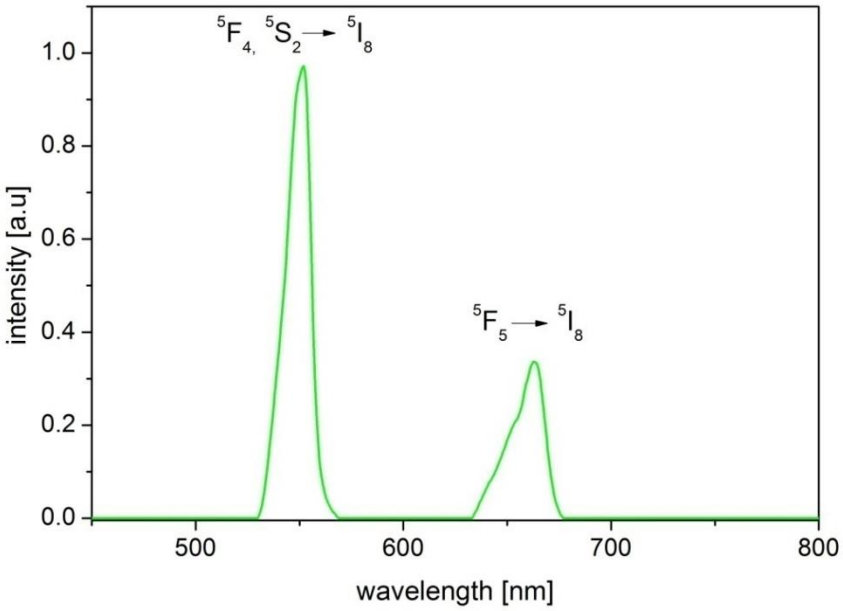
double – clad Yb^{3+}/Ho^{3+} optical fibers

Luminescence of GeO_2 Yb^{3+}/Ho^{3+} and $Yb^{3+}/Tm^{3+}/Ho^{3+}$



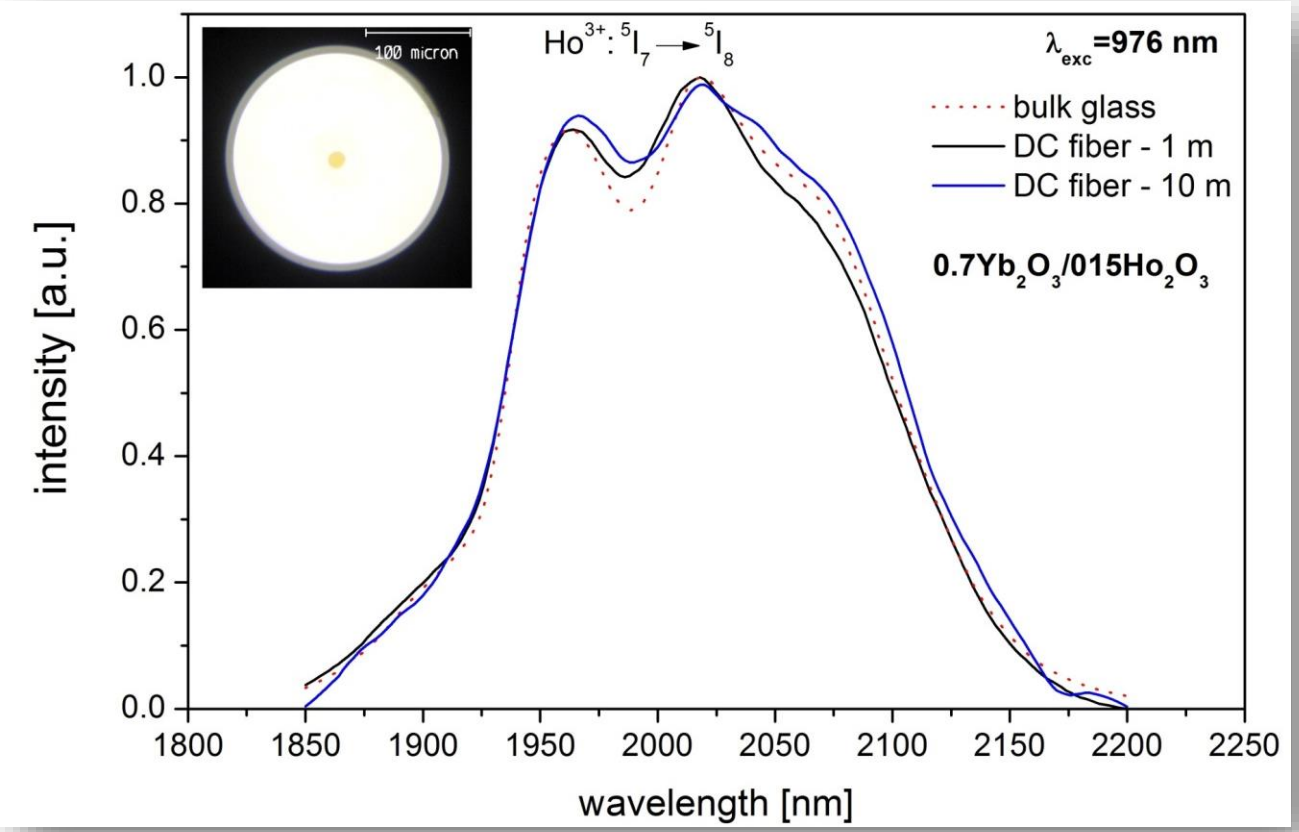
Luminescence of GeO_2 Yb^{3+}/Ho^{3+} fiber





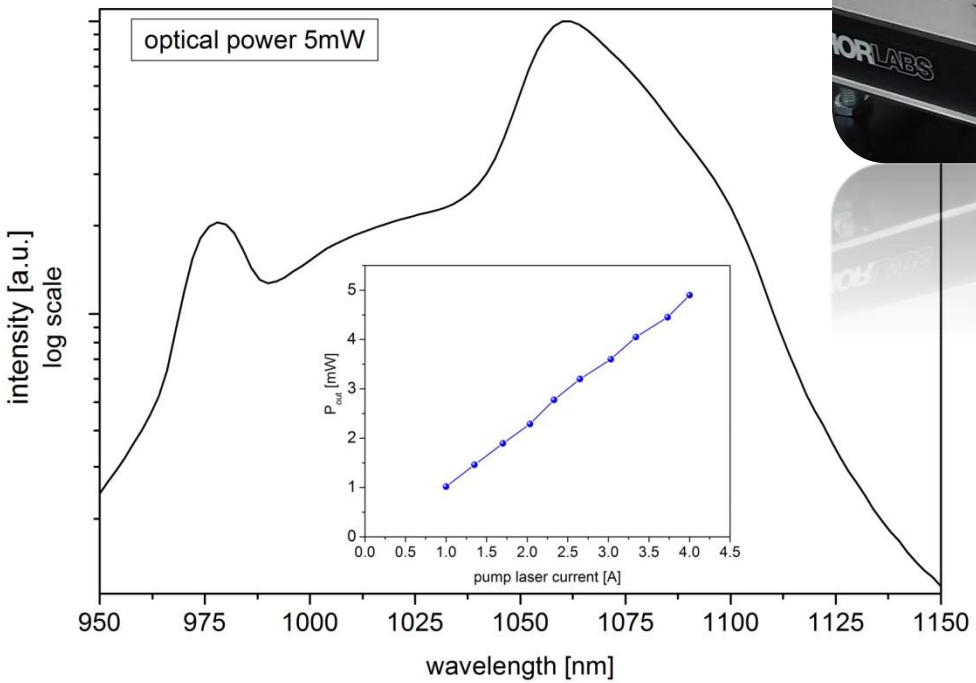
- outer cladding diameter=235 µm
- core diameter=10 µm
- $NA_{cladding}$=0.58
- NA_{core}=0.44
- Attenuation =0.47dB/m, @2000 nm

Luminescence of GeO_2 Yb^{3+}/Ho^{3+} fiber



- outer cladding diameter=250 µm
- core diameter=20 µm
- $NA_{cladding}$=0.58
- NA_{core}=0.44
- Attenuation =0.57dB/m, @2000 nm

ASE source @1 μm - dual-core Nd^{3+}/Yb^{3+} co-doped fiber



Summary

Conclusions:

- **Developement of multicomponent optical fibers** with **A**mplified **S**pontaneous **E**mission:
  - **@1μm** – Nd^{3+}/Yb^{3+}
- **Germano-gallate double - clad** optical fibers enabled to achieved:
- **Yb^{3+}/Tb^{3+}, Yb^{3+}/Eu^{3+} - VIS emission – upconversion (λ_p=976 nm)**
- **Yb^{3+}/Ho^{3+}** - the **wide emission band @2μm** (FWHM ~ 170 nm).
- **$Yb^{3+}/Tm^{3+}/Ho^{3+}$ triply** doped optical glasses are characterized by ultrabroad (**>370 nm**) emission **@2μm**

Summary

Perspectives:

- **Co-doped (double, triply)** double-clad optical fibers enable to construct of **broadband ASE** fiber sources - @2μm
- **Construction of optical fibers characterised by multicolor emission for tunable radiation sources (VIS)**

ACKNOWLEDGMENTS

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