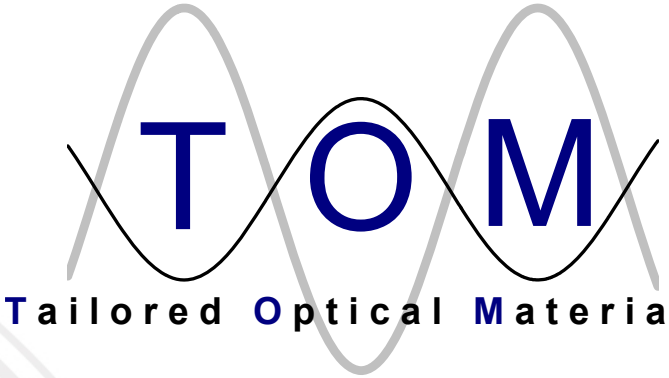
Analytical Measurement Options at Research Group Tailored Optical Materials



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Status: June 2018

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- Excitation Saturation Spectra
- Time and Spectral Flicker Measurements

Dependencies

- Atmosphere
- Excitation energy
- Temperature
- Time

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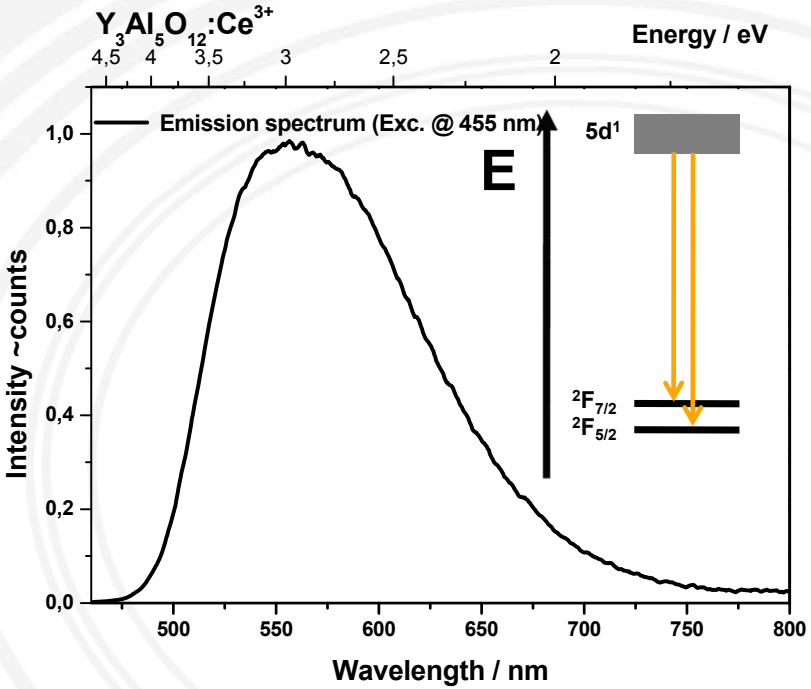
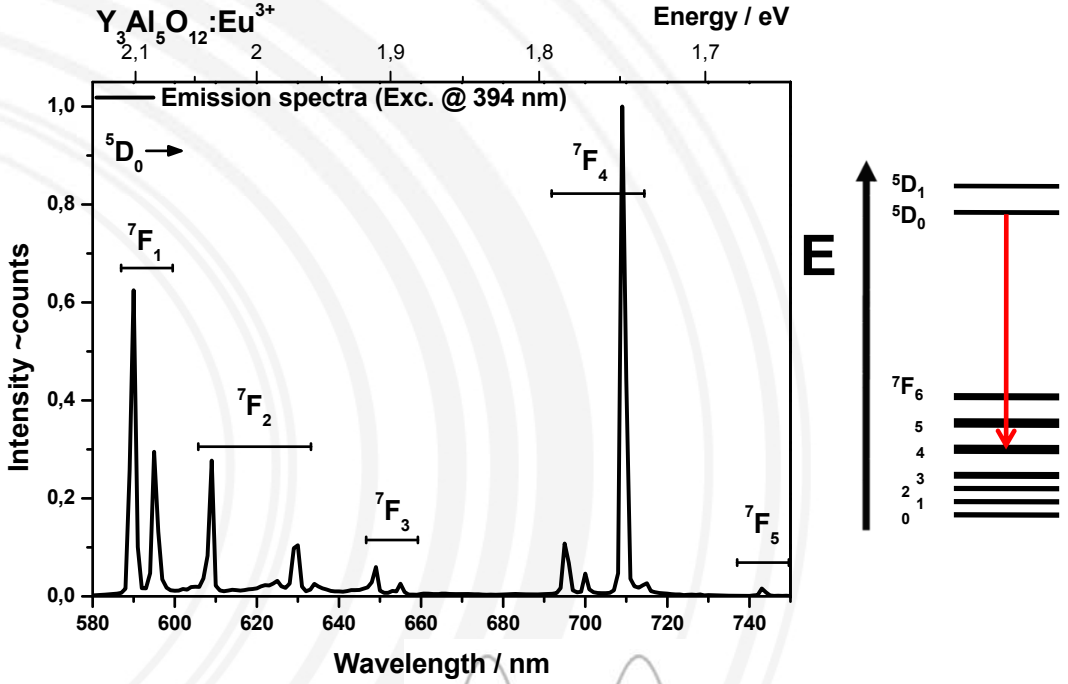
Emission Spectra





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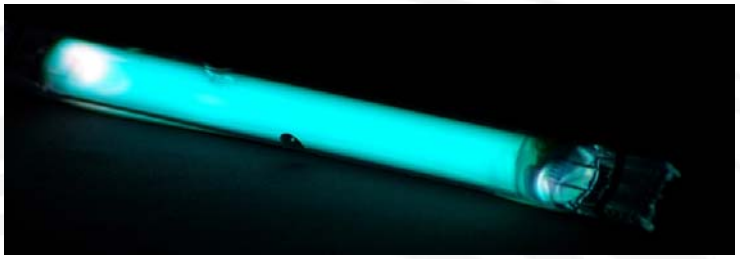
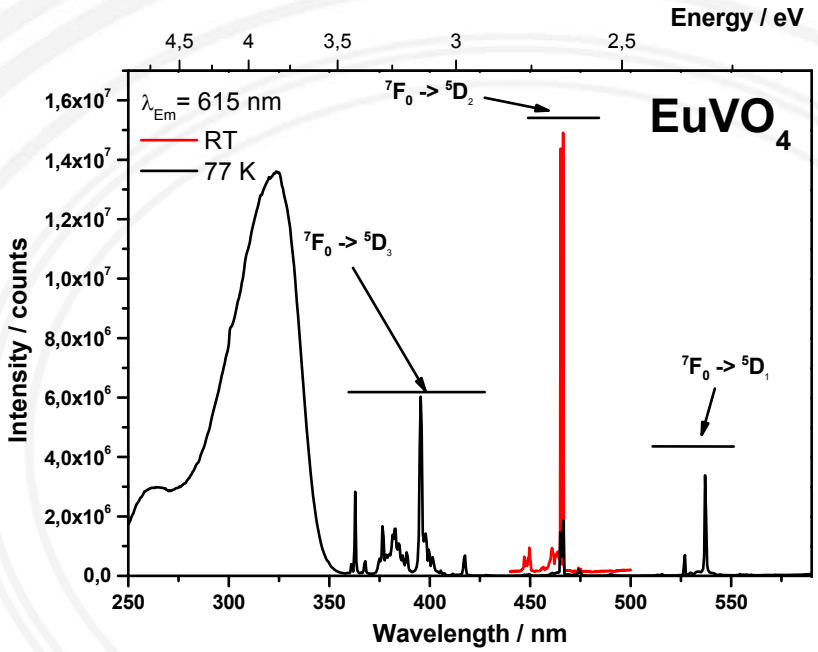
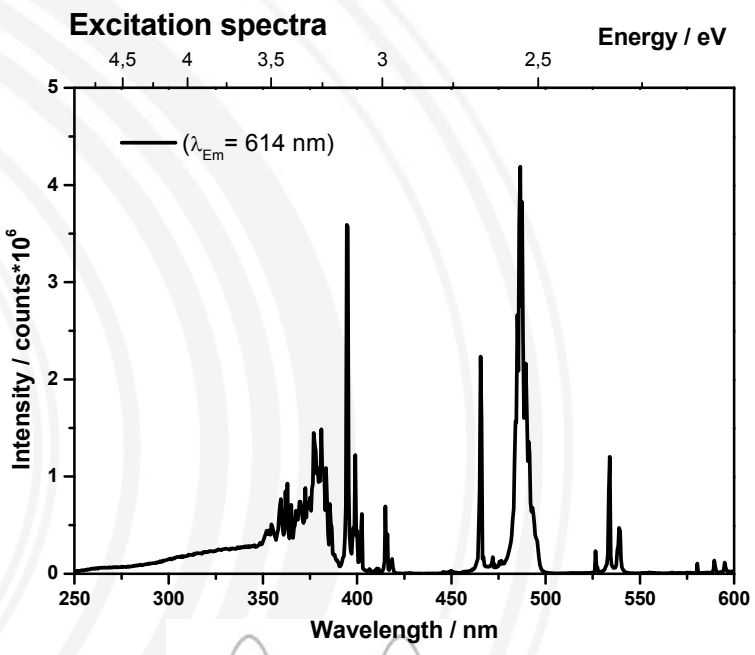
Excitation Spectra







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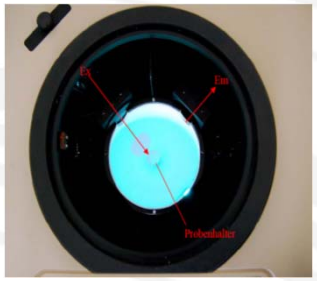
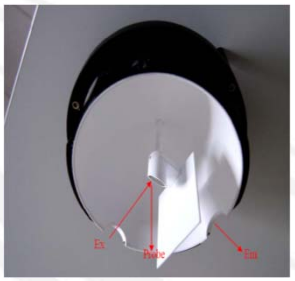
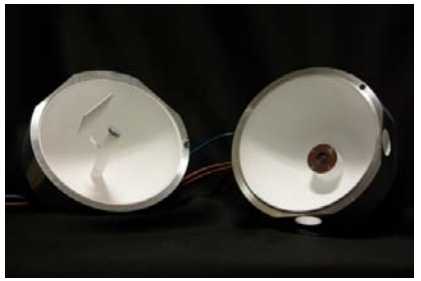
Reflection Spectra

Spectralon (PTFE) coated





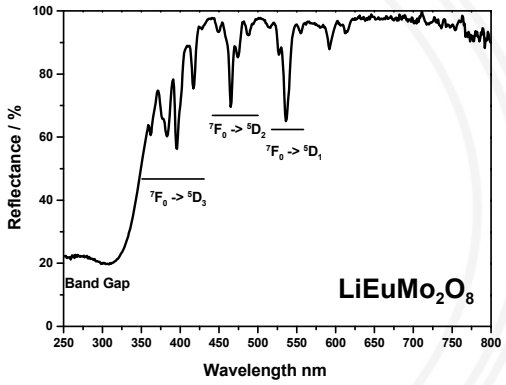
$BaSO_4$ coated

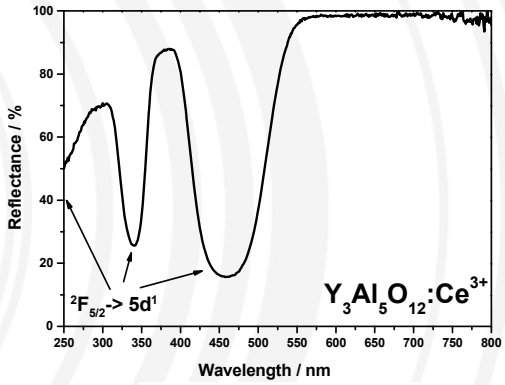


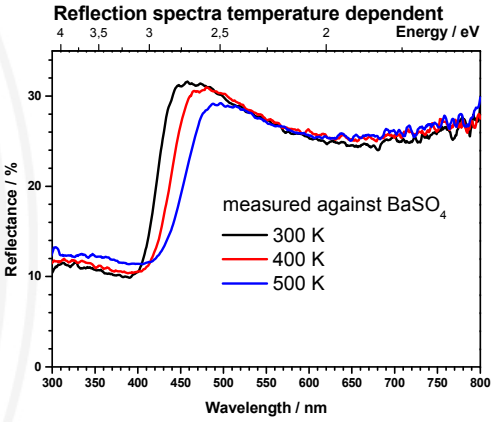
$BaSO_4$ coated, heatable to 500 K

Sample holder made from:

- PTFE
- Fused silica
- Aluminum







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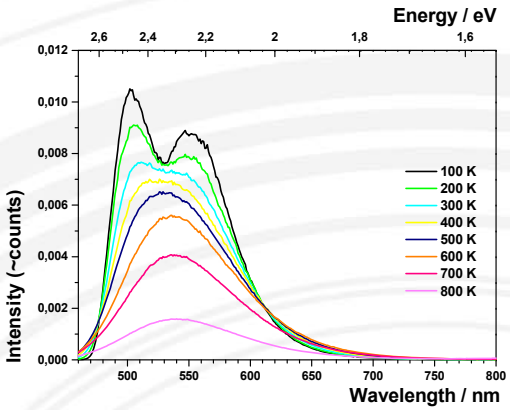
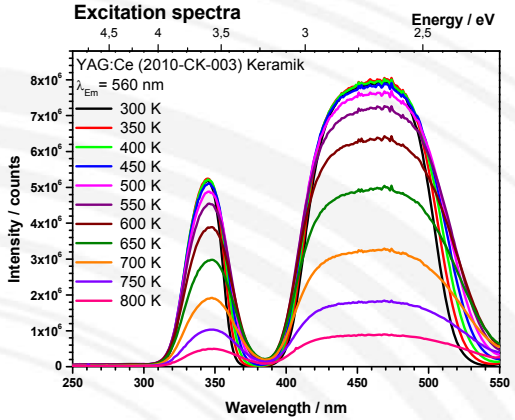
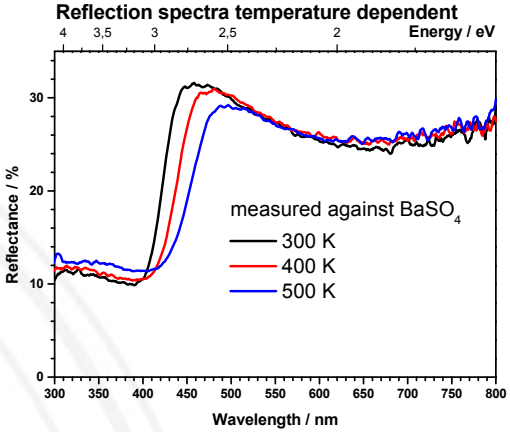
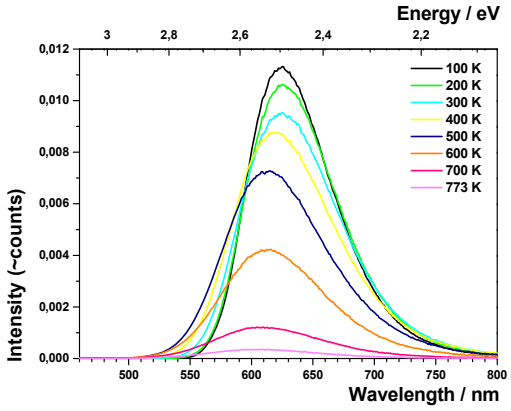
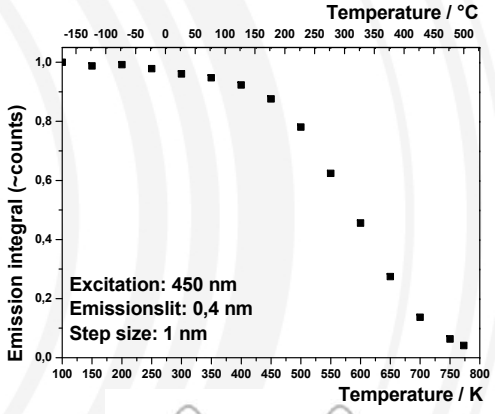
Temperature Dependent Emission, Excitation and Reflection Spectra











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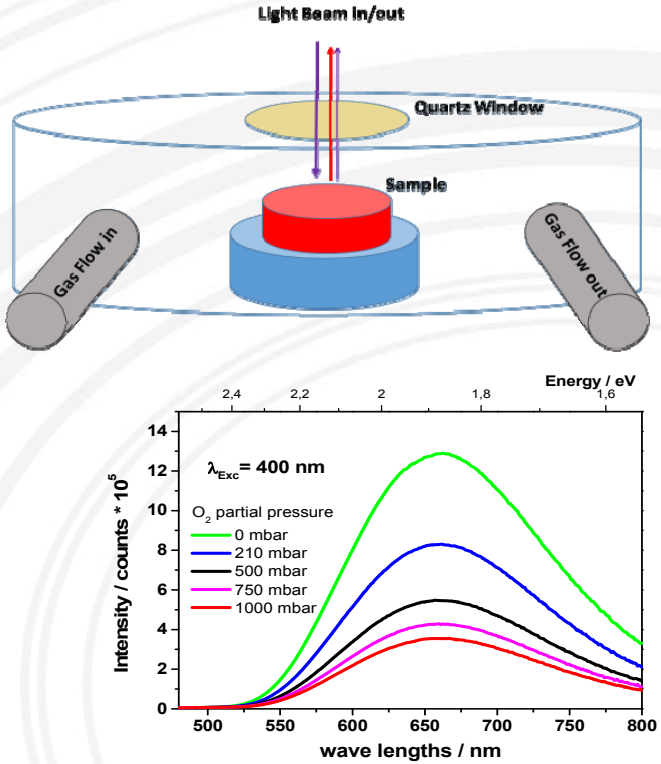
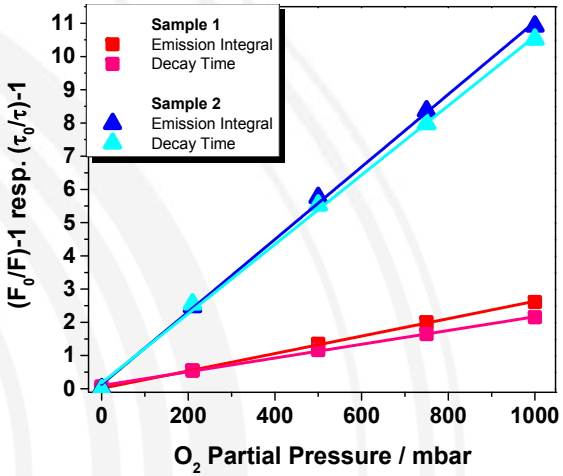
Atmosphere Dependent Emission, Excitation and Reflection Spectra



Emission spectra of microcrystalline phosphor powder under several oxygen partial pressure

Emission-, excitation-, reflection spectra, and decay curves under different atmospheres



Stern-Volmer plots of the emission integrals as well as the decay times of two microcrystalline phosphors as a function of oxygen partial pressure

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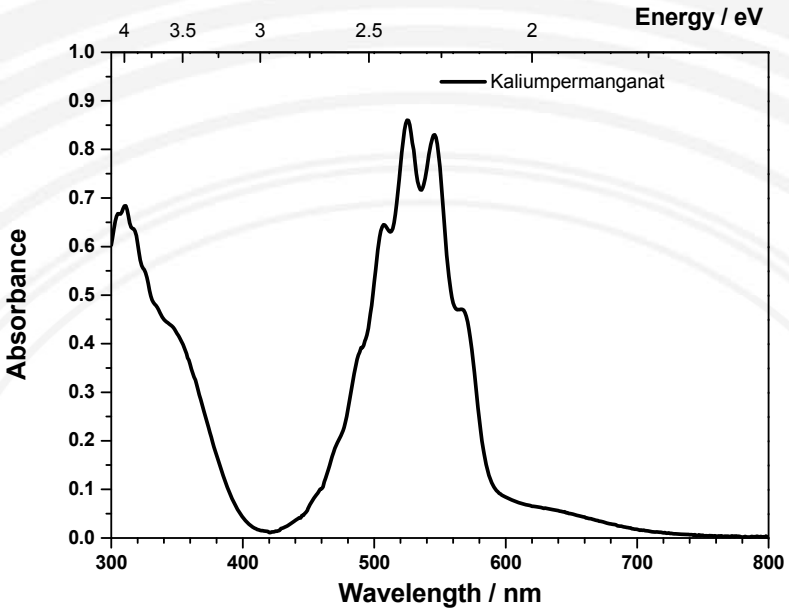
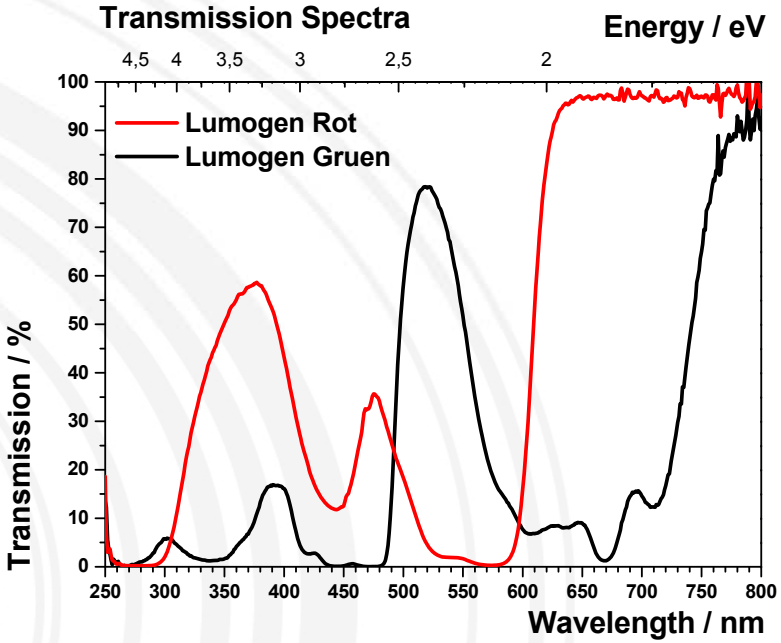
Transmission Spectra





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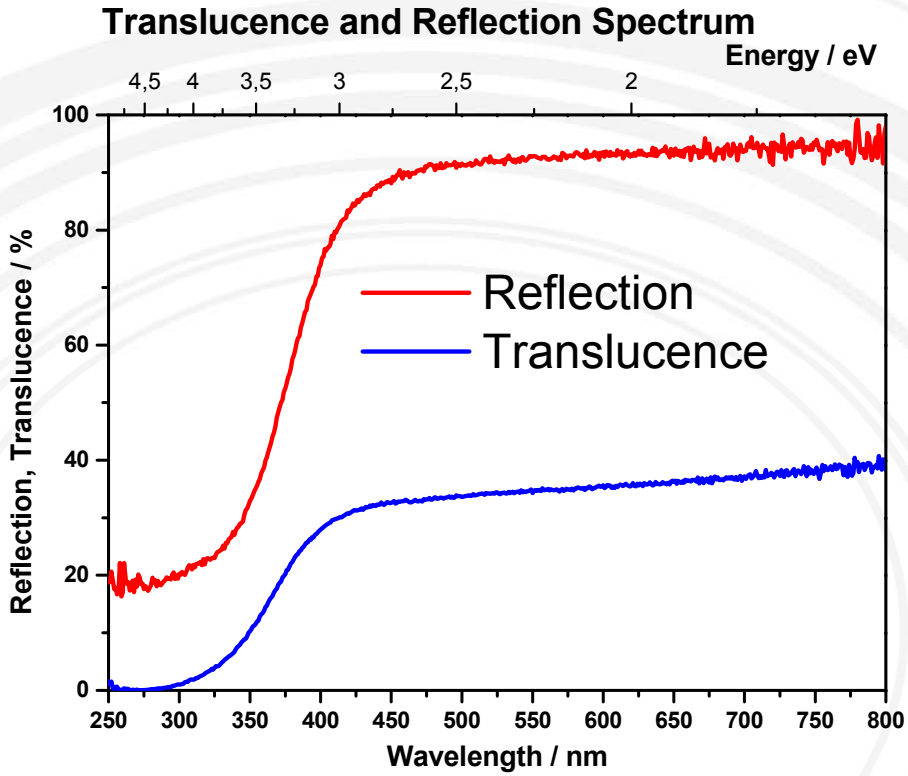
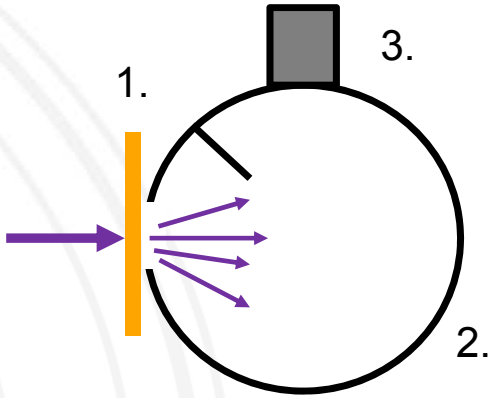
Translucence Spectra





1. Sample
2. Integrating Sphere
3. Detector

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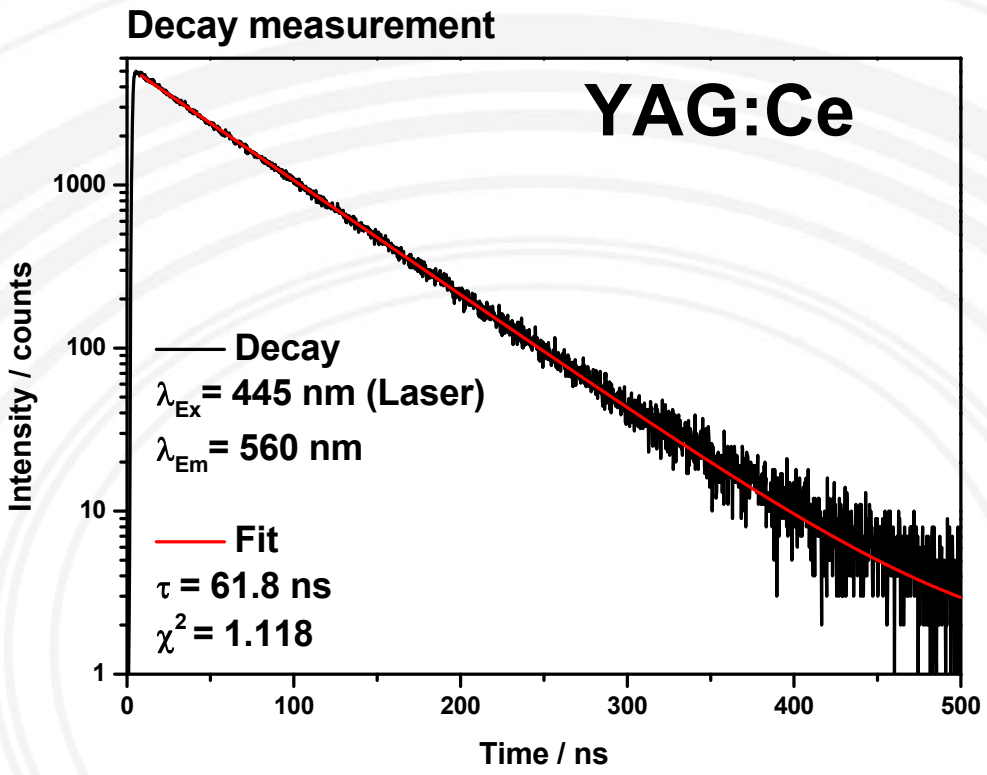
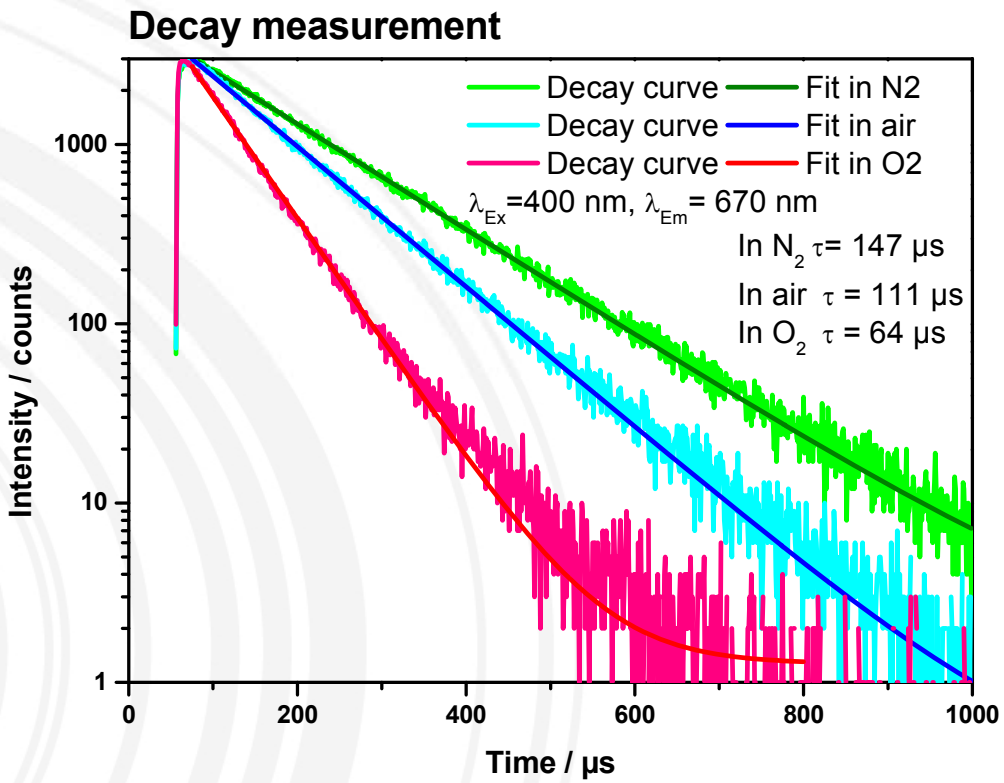
Decay Curves





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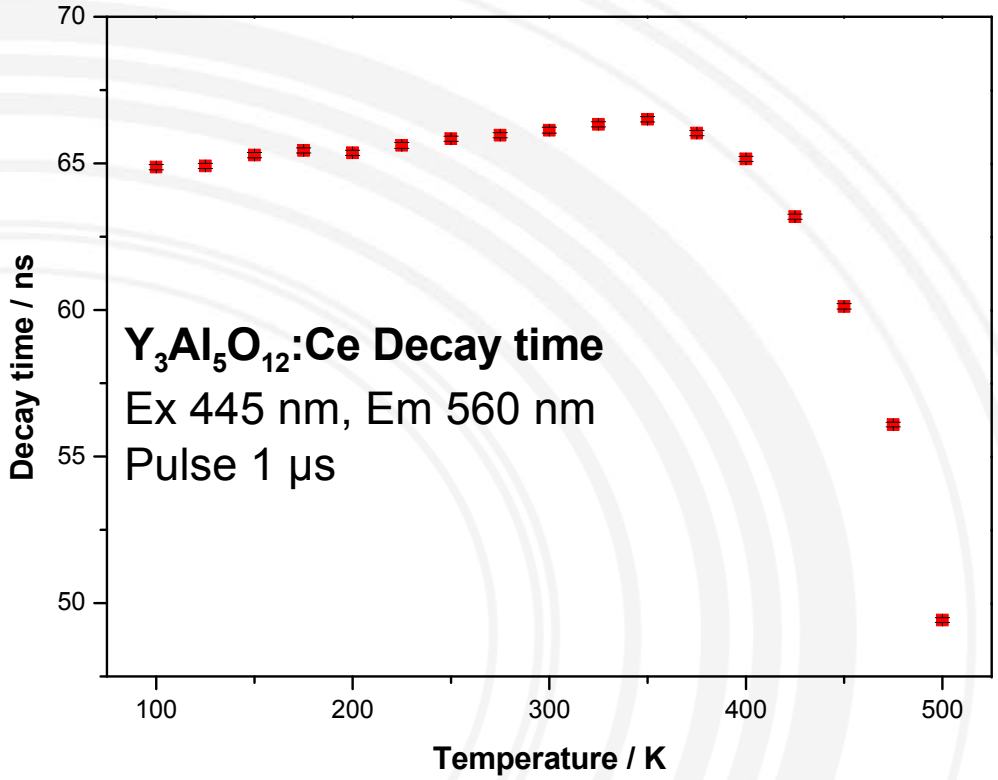
Temperature Dependent Decay Curves



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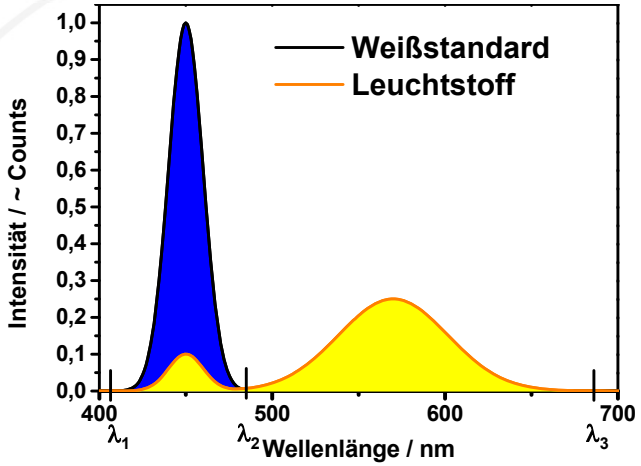
Quantum Efficiency

Integrating sphere method
against a white standard

$$\phi_{Probe} = \frac{nE}{nA} = \frac{\int_{\lambda_2}^{\lambda_3} \frac{\lambda}{hc}\left[I_{Emission}^{Probe}(\lambda) - I_{Emission}^{Referenz}(\lambda)\right] d\lambda}{\int_{\lambda_1}^{\lambda_2} \frac{\lambda}{hc}\left[I_{Anregung}^{Referenz}(\lambda) - I_{Anregung}^{Probe}(\lambda)\right] d\lambda}$$



Relative method
against a phosphor sample with known quantum efficiency

$$\phi_P = \phi_R * \frac{A_R * E_P}{A_P * E_R}$$

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Absolutely Radiant and Luminous Flux Spectra

System: Illumia plus (Labsphere)
Spectral flux: 250 nm - 850 nm
Spectra recording: 200 nm - 1100 nm
Minimum measurable
Lumens (typical): 0.04 lumens
Maximum measurable
Lumens (typical): ~ 46000 lumens
(Cool white LED source)
Exposure time range: 1 ms - 5^3 s
(actual exposure time depends
on sphere size and source type)

Software:
Integral LM: Included

Standards:
LM-79: Included
LM-82: Module available

Spectrometer:
CDS600 and CDS610
2048 element Linear CCD
200 – 850 nm and
350 – 1100 nm

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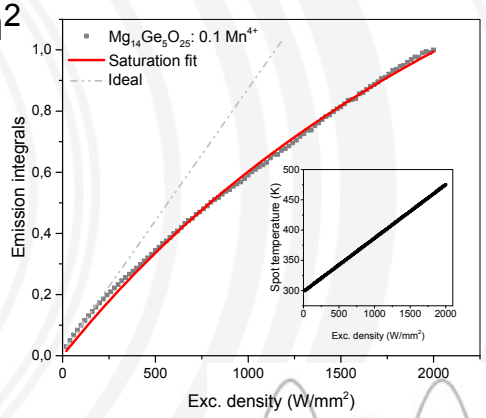
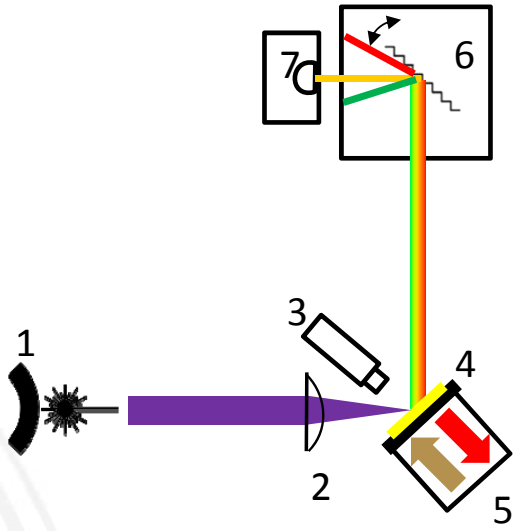
Excitation Saturation Spectra

- **Fluorescence spectrometer**
  - **Laser excitation for saturation measurements (continuous)**
    - 375 nm Laser (50 mW) up to 500 W/mm²
    - 405 nm Laser (200 mW) up to 2000 W/mm²
    - 445 nm Laser (80 mW) up to 800 W/mm²
    - 488 nm Laser (150 mW) up to 1500 W/mm²





1 - Laser diode 445 nm (80 mW) up to 800 W/mm²
2 - Focusing lens
3 - Pyrometer
4 - Sample
5 - Passive cooling (Ag sample holder)
6 - Emission monochromator
7 - Detector (PMT)

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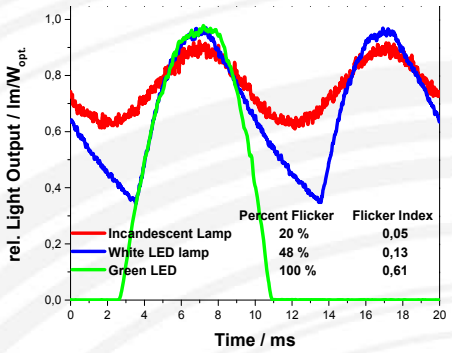
Intensity as Function of Time and Spectral Flicker Measurements

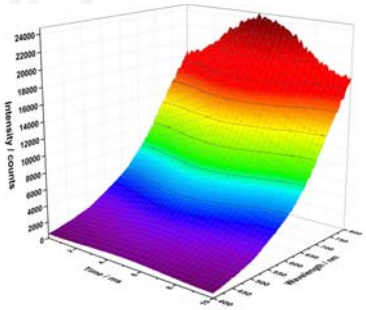


Flicker characterization of different light sources

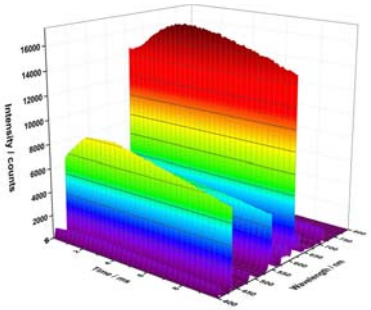
The 3D plot illustrates the emission intensity profile as function of time and wavelength

Strong flicker

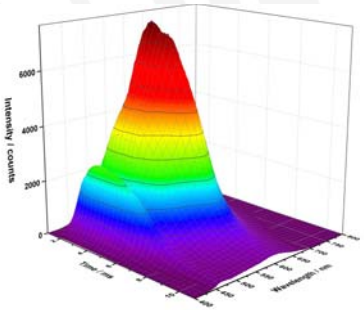
Flicker free

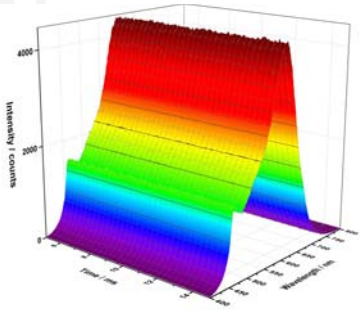


Halogen bulb



CFL





Two different types of filament LED lamps

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Excitation Options

Xenon bulb, wavelength range 200 nm to 900 nm

Fianium Supercontinuum SC450-4 White Light Laser, wavelength range 460 nm to 2.4 µm

X-Ray Tube Neptune 5200
Voltage Range: 10 - 50 kV
Max. Power: 100 W

Deuterium bulb, wavelength range 120 to 400 nm

EPL ps Laser, wavelength 265, 375, and 445 nm

Continuous Laser wavelength 375, 405, 445, and 488 nm

Various standard LEDs from 250 to 1100 nm

Americium source, α- and γ-Radiation

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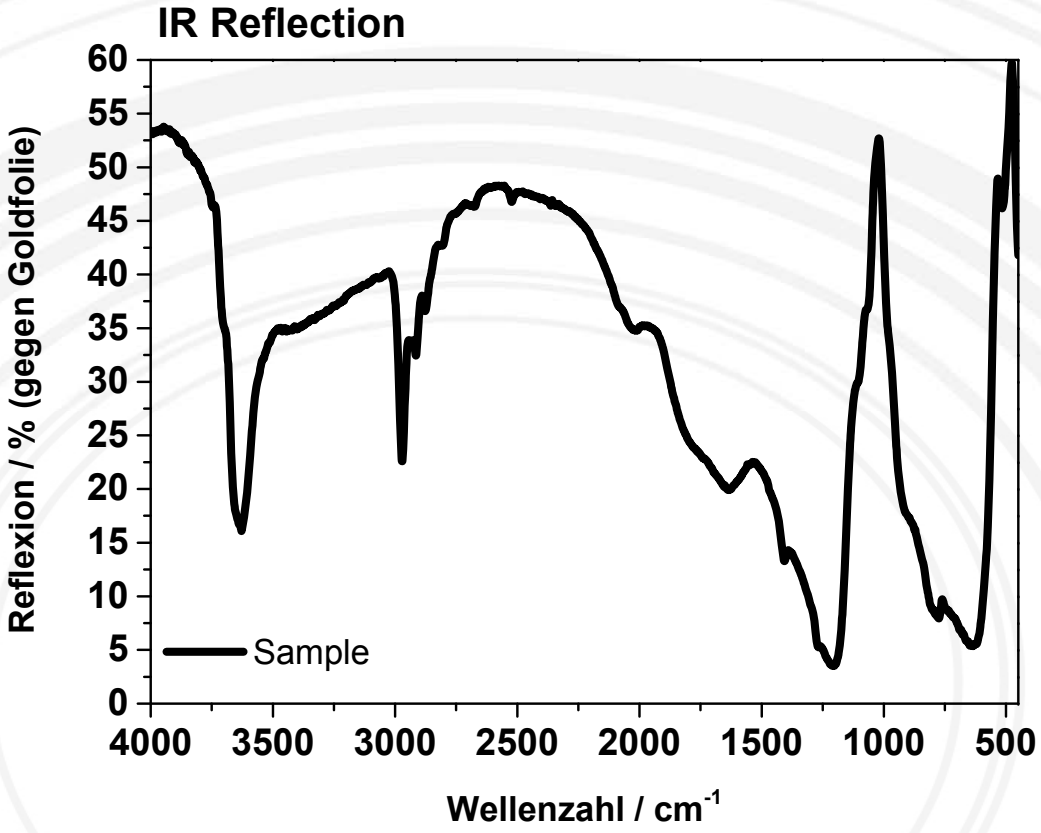
Infrared Spectra



Spectral Range 400 – 4000 cm^{-1}

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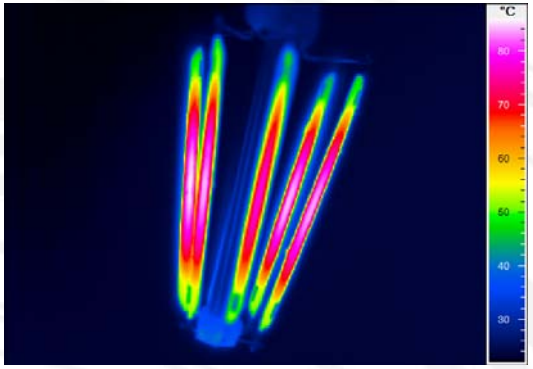
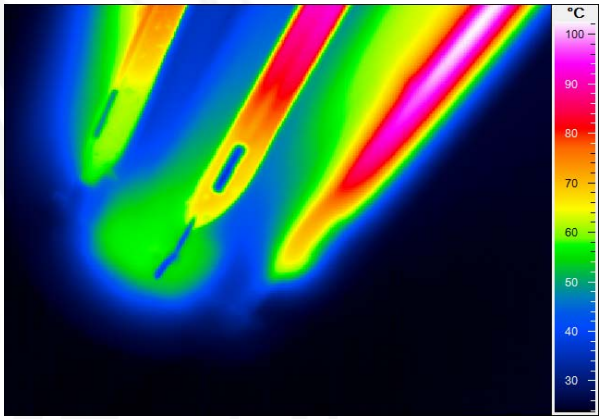
Infrared Images



VarioCAM head HiRes 384 G



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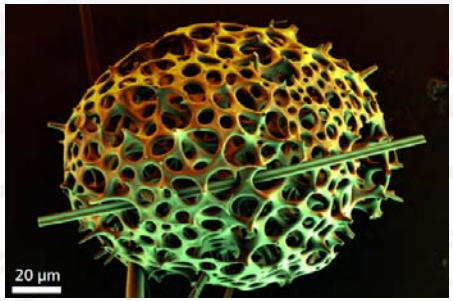
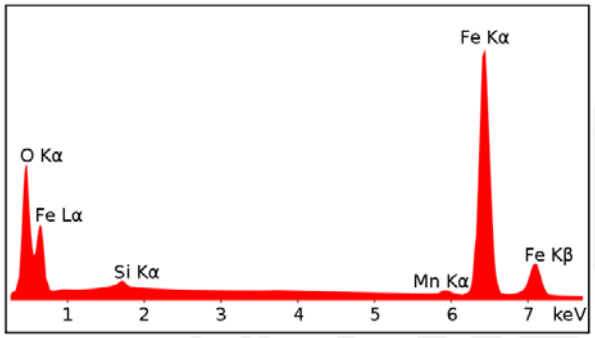
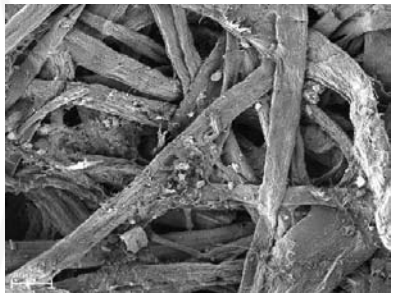
Scanning Electron Micrographs and Energy Dispersive X-Ray Spectra (SEM and EDX)







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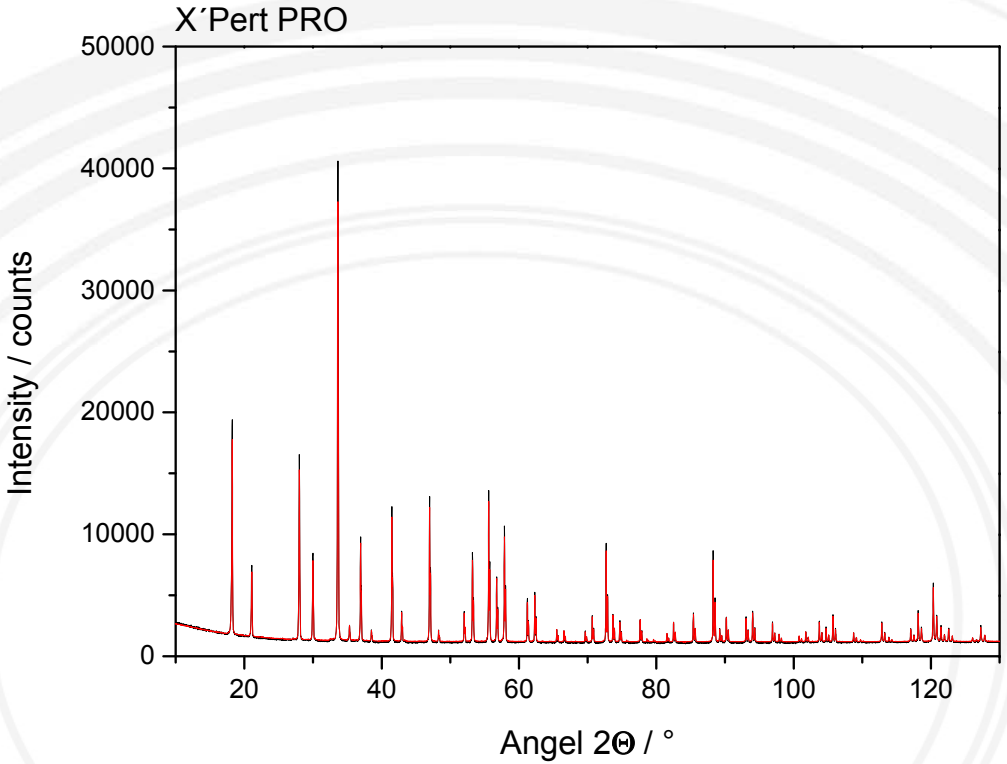
X-Ray Diffraction Patterns



PANalytical X´Pert PRO

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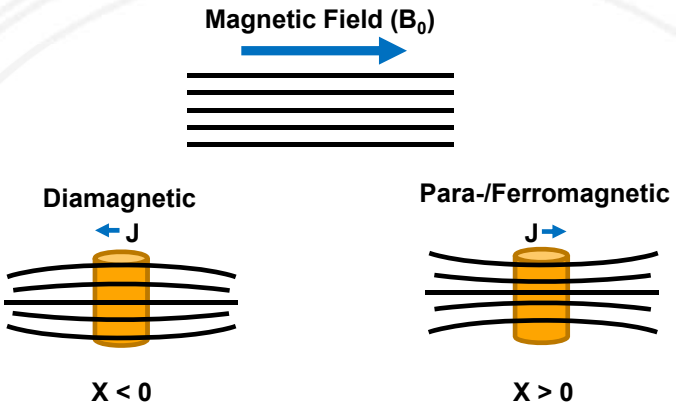
Magnetic Susceptibility

Range $1 \cdot 10^{-10}$ to $1.99 \cdot 10^{-4}$ volume susceptibility units

Conversion to mass susceptibility by calculating the sample density in the test tube



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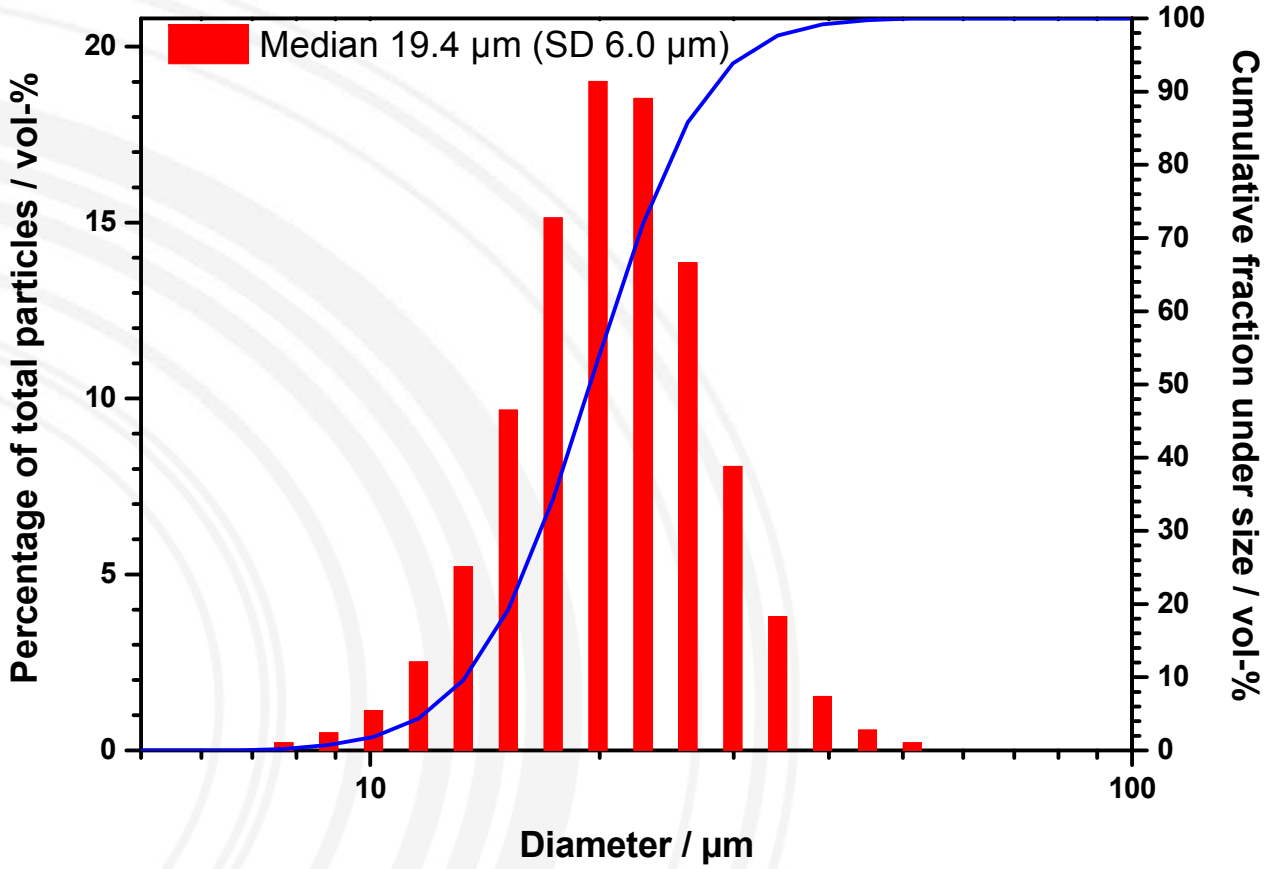
Particle Size Distribution Determination

Horiba LA-950-V2 organic
Particle size range 10 nm – 3 mm

Malvern NanoSizer
Particle size range 0.4 nm – 10 µm

Malvern MasterSizer X
Particle size range 100 nm – 2 mm



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Elemental Analysis

N-/O-Analyser LECO TC 400

C-/S-Analyser ELTRA CS 800

**Elemental analysis of
nitrogen, oxygen, carbon and sulfur
ranging from 0.1 to 100% by weight**

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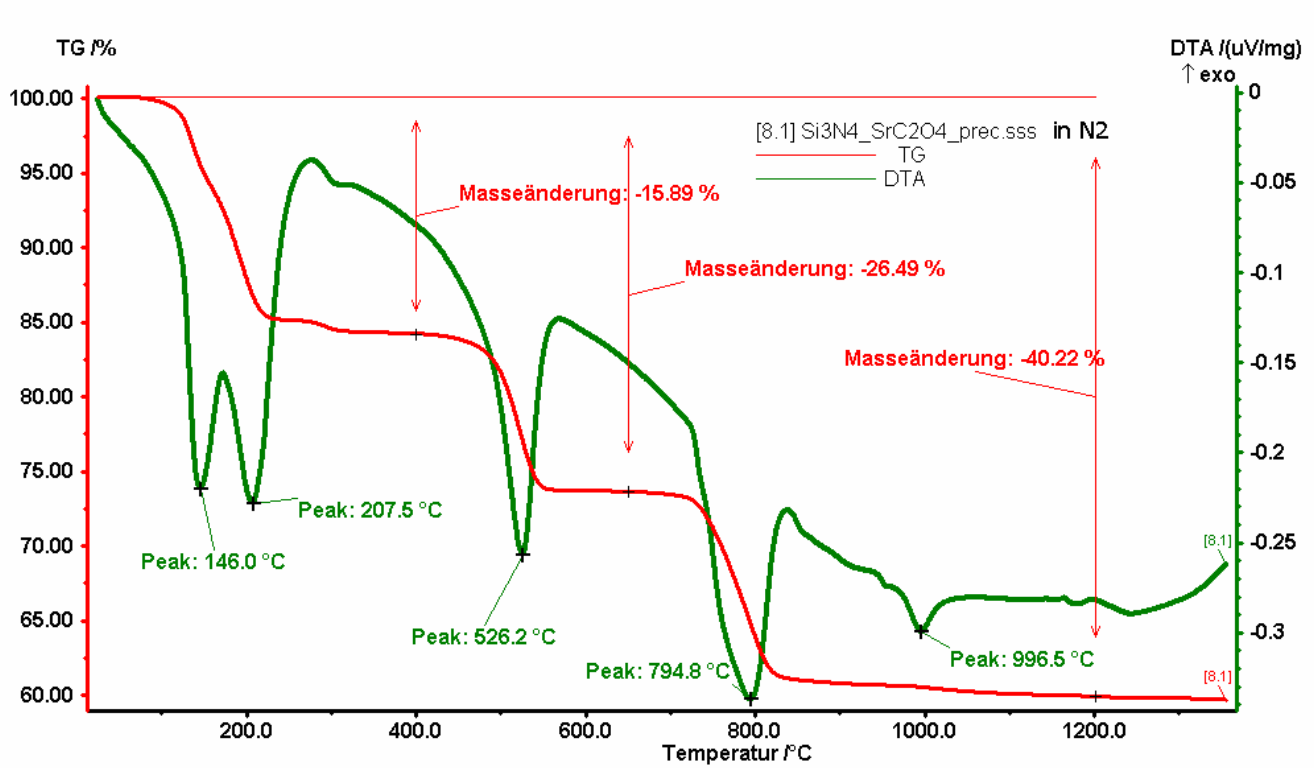
Differential Thermal Analysis and Thermogravimetry (DTA and TG)

Netzsch STA 409



- **Decomposition**
- **Change in phase**
- **Melt**
- **Evaporate**
- **Chemical reaction**

from room temperature up to 1350 °C under different atmospheres

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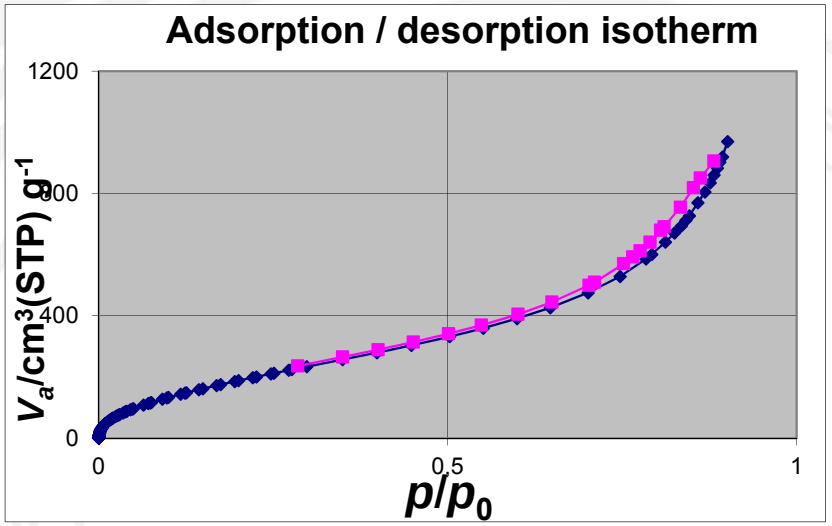
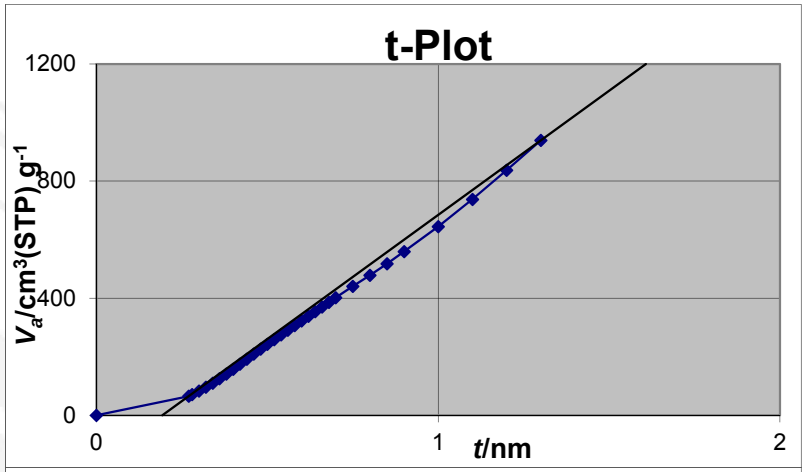
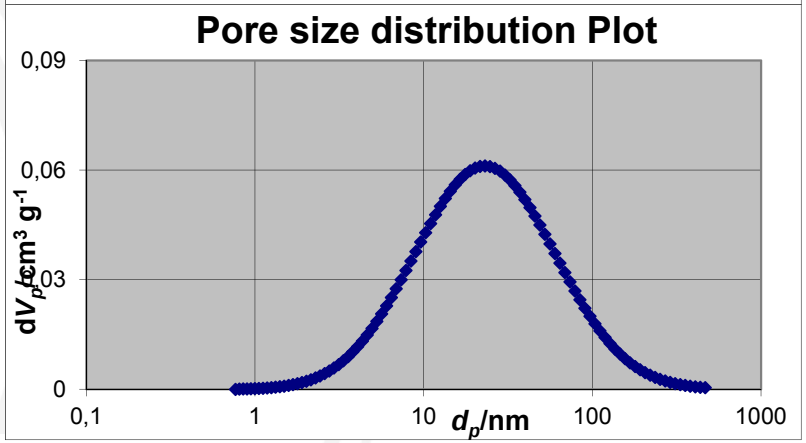
Brunauer–Emmett–Teller (BET) Surface Measurements

Belsorp Max



N_2 / 77 K





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