

Scintillating aerogels from gels obtained by controlled destabilization of aqueous colloidal solutions: toward radiometry

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Key words

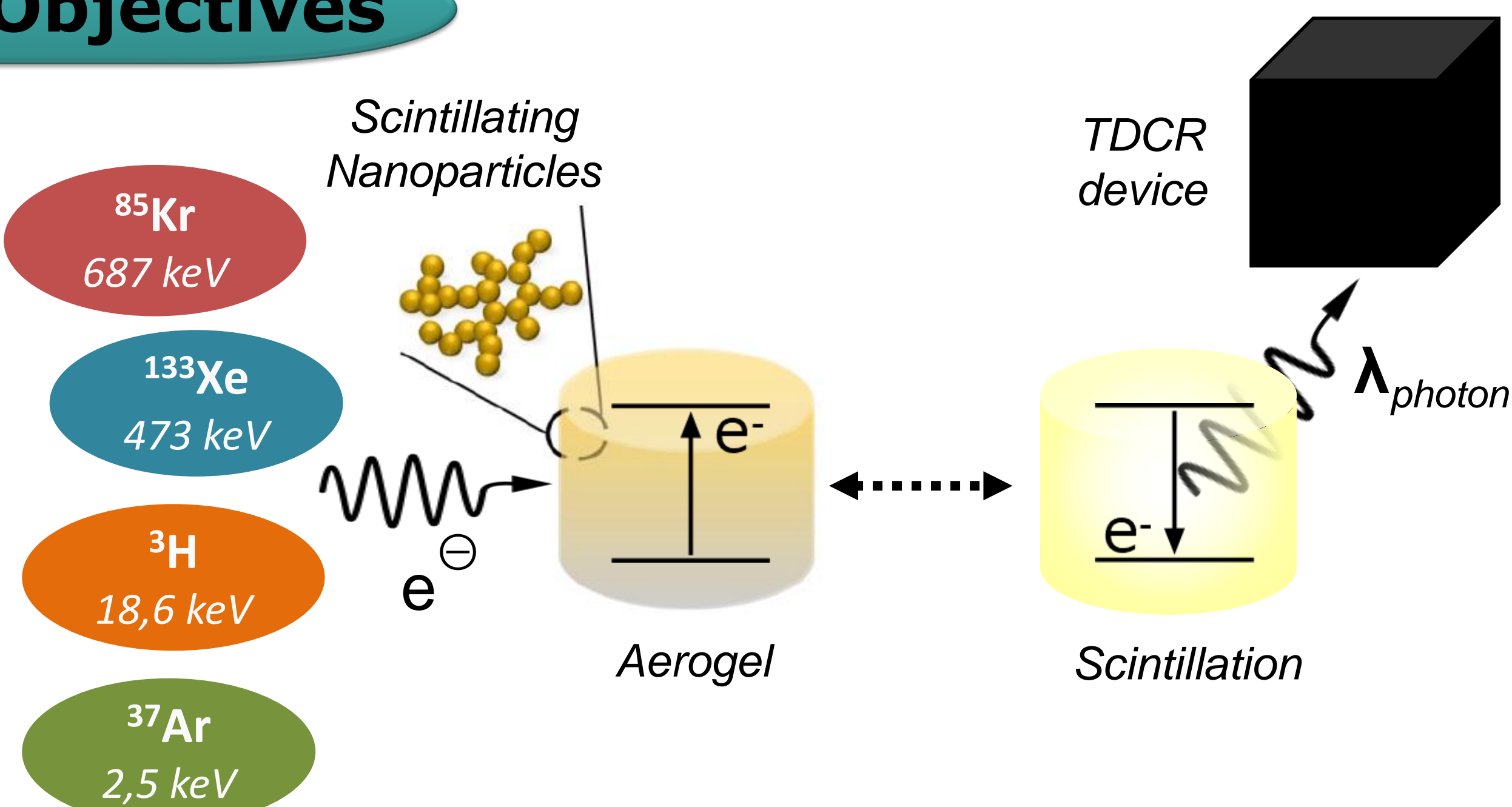
Aerogels • YAG:Ce nanoparticles • Colloidal Solution • Scintillators • Radioactive gas detection

Introduction

Radioactive gases are key targets for the environment, making gas monitoring an important issue. SPARTE will focus on the detection and **activity measurement metrology** of tracers related to nuclear activities. Measurement of a low energy **ionizing radiation** is difficult due to a **short mean free pathway** of emitted particles. This means that beta and alpha particles are easily stopped by matter and never reaching a detector. Nowadays, such measurements are performed by using **liquid scintillators** which possess **several disadvantages**: i) uncertainty of measurement; ii) limited efficiency.

Therefore, we aim to develop alternative approach using **porous inorganic scintillators** for **Radioactive gas detection**.

Objectives



Methods

1. Glycothermal synthesis and treatment of Scintillating NPs (YAG:Ce)

- Small size, high stability in water

2. Gelification and Supercritical drying

- Transparency, porosity, mechanical strength

3. Optimization of the optical properties of the aerogel

- Fast and Efficient Scintillation, events with radionuclides

References

- [1] M. Odziomek, F. Chaput, F. Lerouge, C. Dujardin, M. Sitarz, S. Karpati, S. Parola *Chem. Mater.* **2018** 30 (15), 5460-5467
 [2] M. Nyman, L.E. Shea-Rohwer, J.E. Martin, P. Provencio, *Chem. Mater.*, **21**, 1536-1542, (2009)

Results

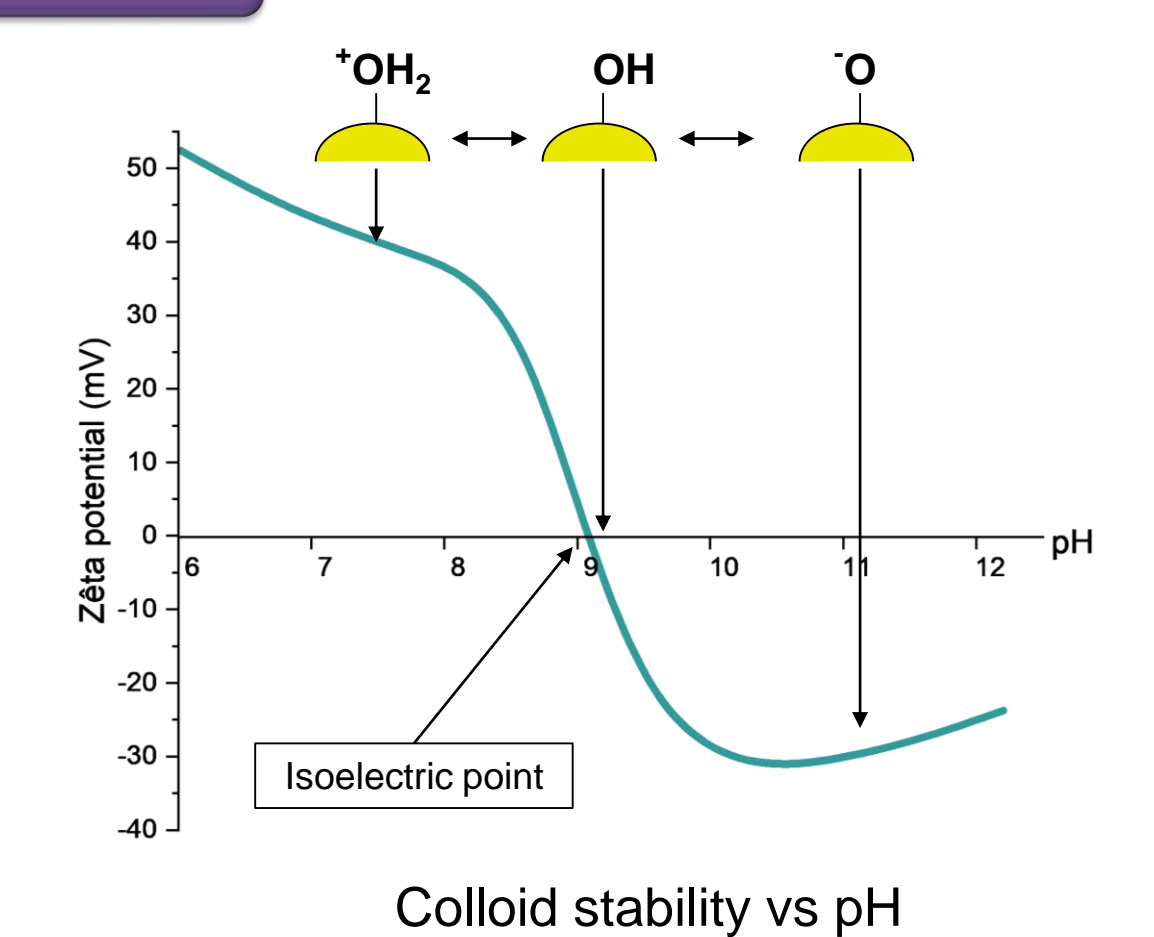
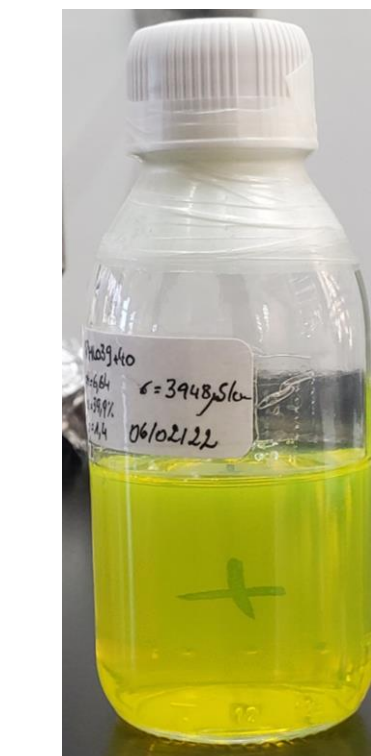
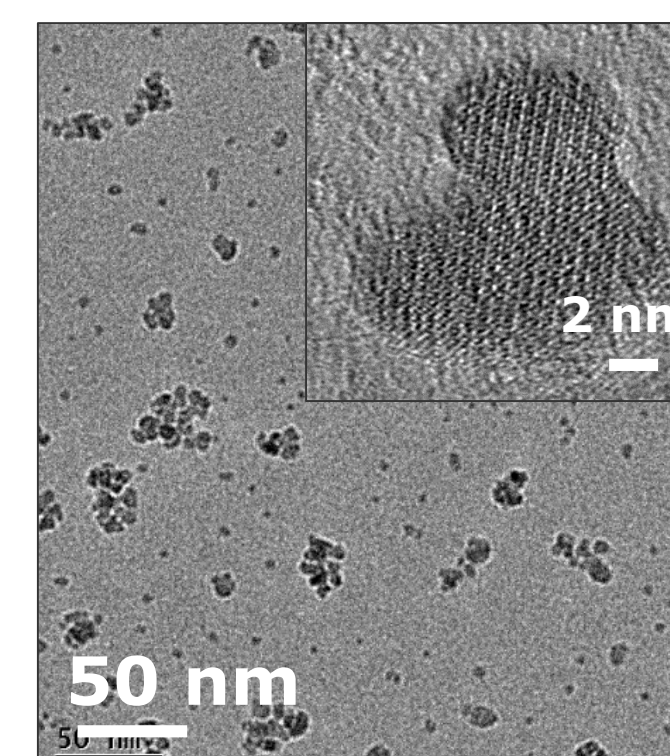
YAG:Ce nanoparticles synthesis

Selective Glycothermal Synthesis:

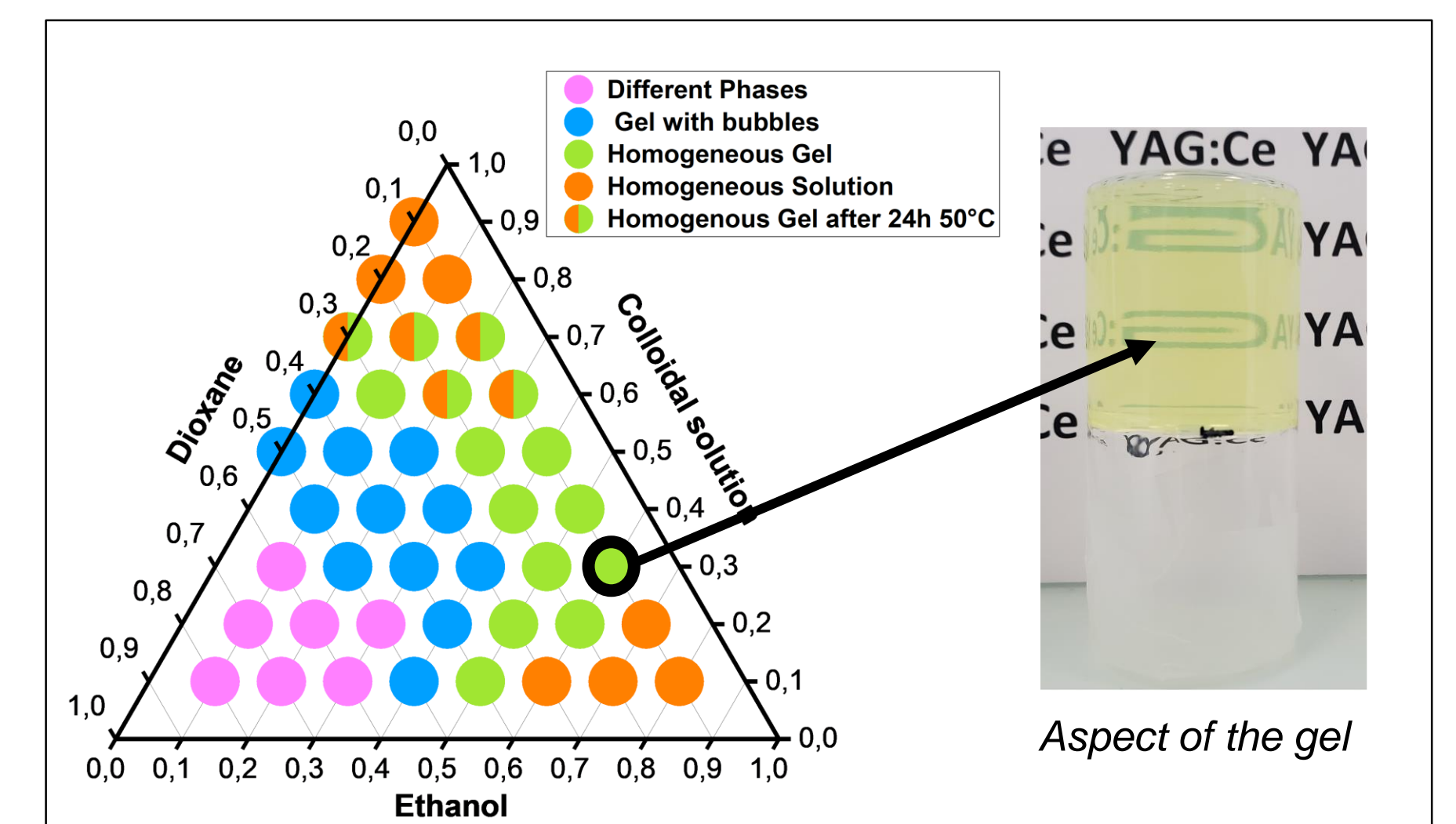
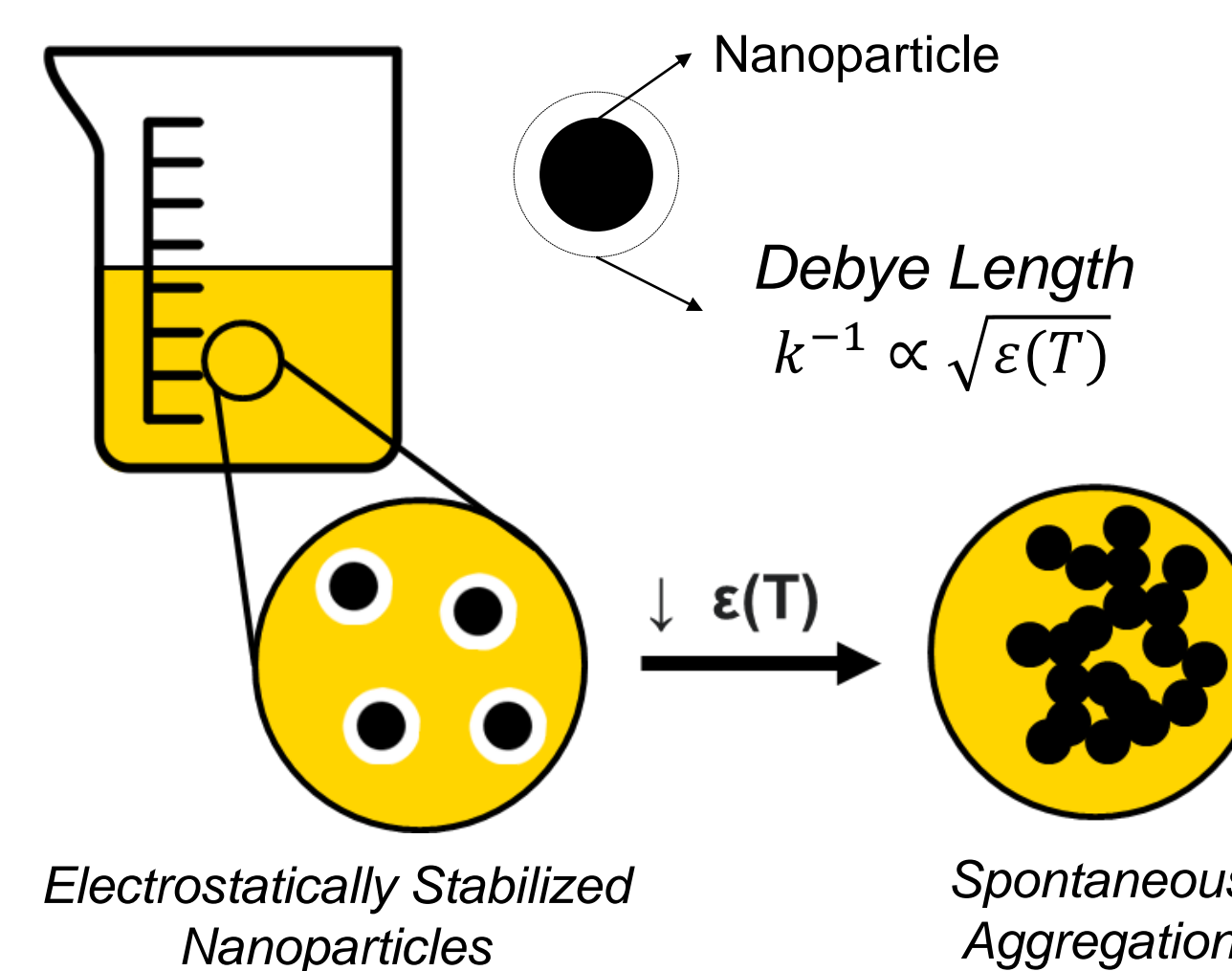
- 5 to 15 nanometers NPs
- YAG:Ce

Treatment of NPs:

- Bleaching
- Electrostatically stable

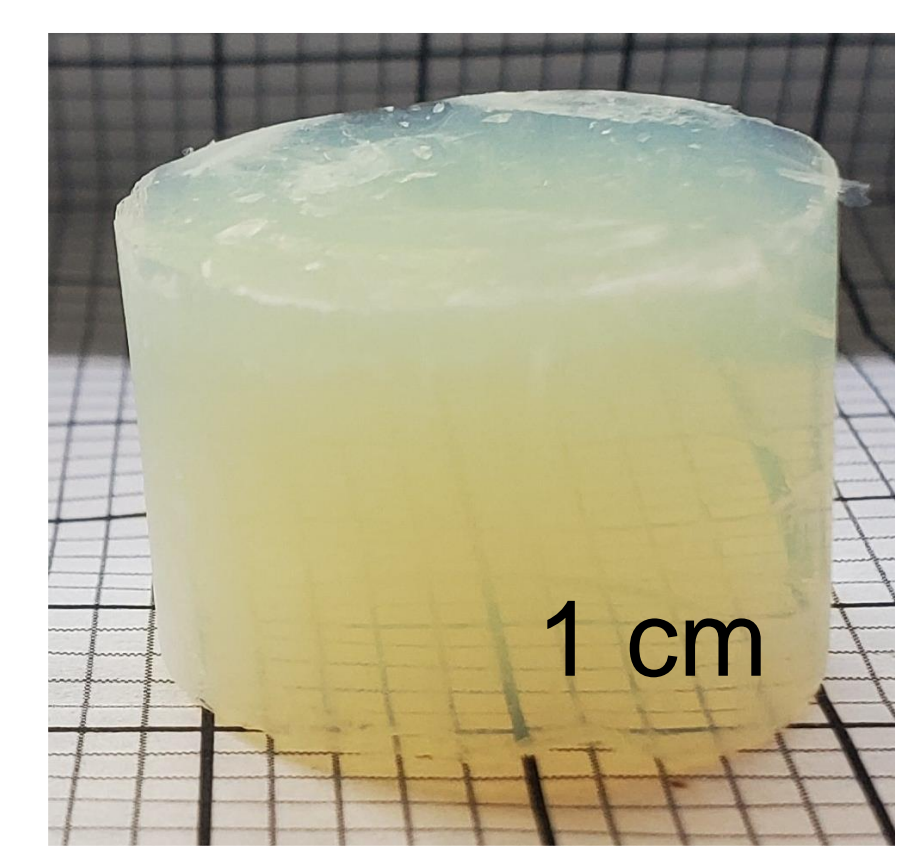


Destabilization of the colloid : Gelification



Scintillation properties

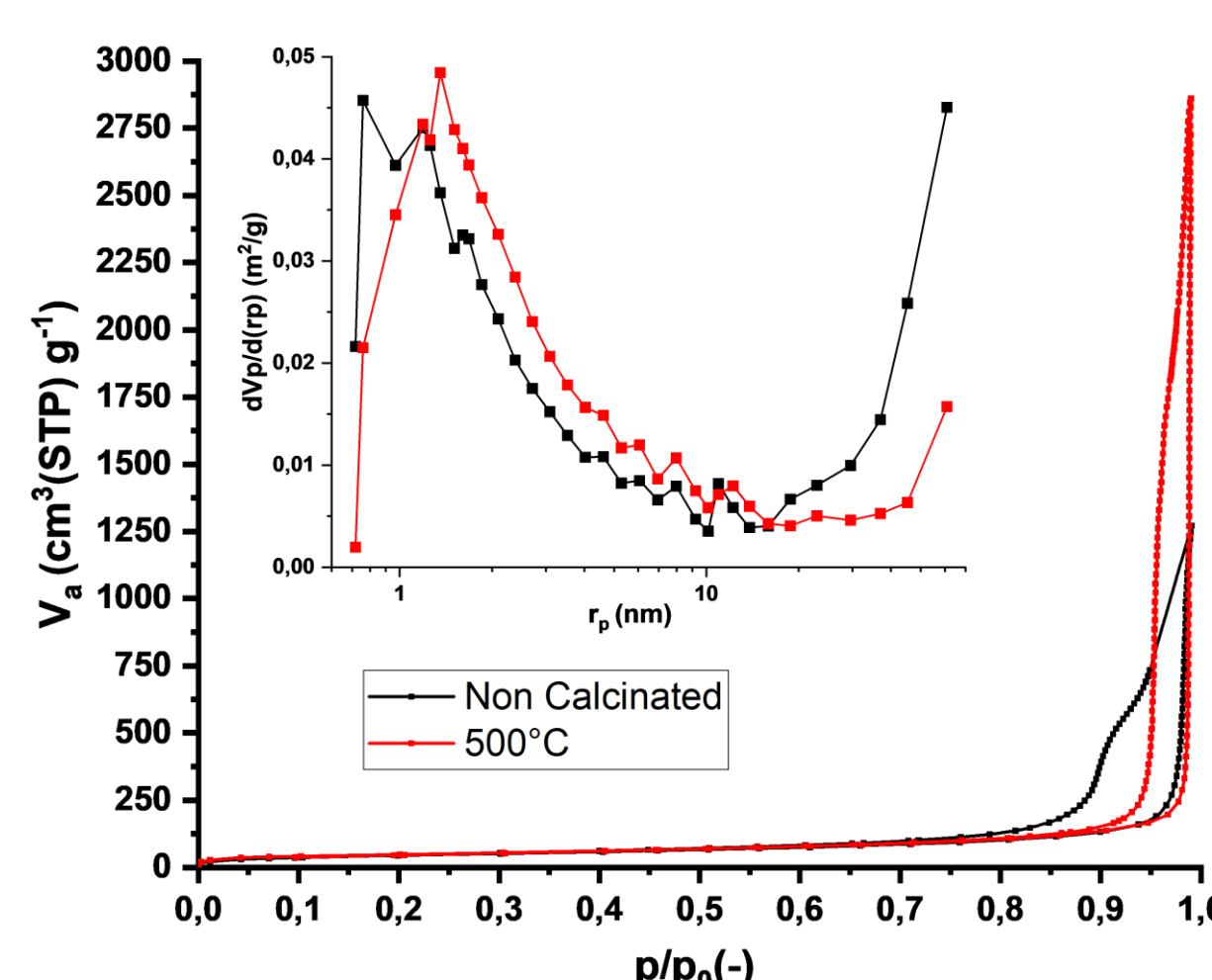
- Oxidation state of Cerium → Calcination Temperature (shrinkage)
- Transparency → Pore size distribution
- SCD conditions



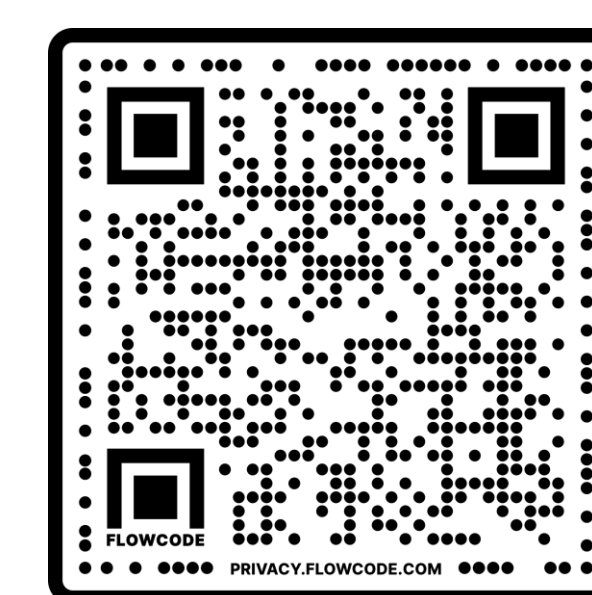
CO₂ Supercritical drying

Properties of aerogel

Porosity

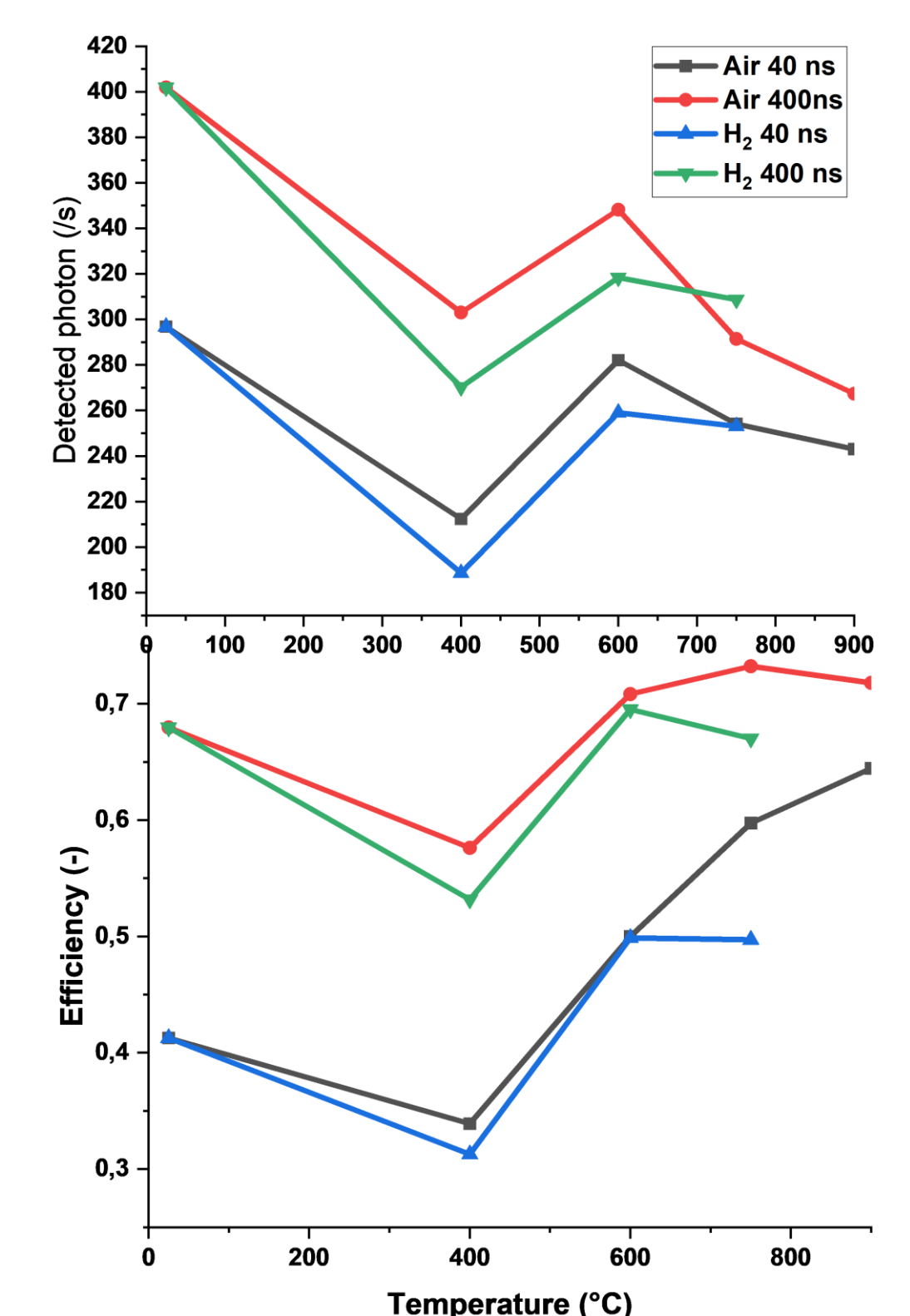


Electron Tomography of non-calculated and calcinated aerogels



Bottom: Isotherms of Adsorption and desorption depending on calcination
 Top: Pore Size distribution by BJH plot

Radioluminescence



Conclusions

- We developed versatile synthetic route for monolithic aerogels of pure crystalline nanoparticles with high porosity, very good transparency and therefore good scintillating properties.
- First tests of low-energetic radiation detection of gaseous radionuclides are very promising. **Please ask me for details if you are interested in ☺**



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