



HAL
open science

Nanoparticle-based Scintillating Aerogels for Real-time Radioactive Gas Detection

Yannis Cheref, Raphaël Marie-Luce, Pavlo Mai, Frédéric Lerouge, Sylvie Pierre, Benoit Sabot, Frédéric Chaput, Christophe Dujardin

► **To cite this version:**

Yannis Cheref, Raphaël Marie-Luce, Pavlo Mai, Frédéric Lerouge, Sylvie Pierre, et al.. Nanoparticle-based Scintillating Aerogels for Real-time Radioactive Gas Detection. 23rd international conference on advanced nanomaterials (ANM2024), Jul 2024, Aveiro (Portugal), Portugal. hal-04863385

HAL Id: hal-04863385

<https://hal.science/hal-04863385v1>

Submitted on 23 Jan 2025

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Nanoparticle-based Scintillating Aerogels for Real-time Radioactive Gas Detection

Yannis Cheref^{1,2,*}, Raphaël Marie-Luce¹, Pavlo Mai², Frédéric Lerouge¹, Sylvie Pierre³, Benoit Sabot³, Frédéric Chapat¹, Christophe Dujardin^{2,4}

¹ Laboratoire de Chimie, ENS de Lyon, Université Claude Bernard Lyon 1, CNRS, UMR 5182, France

² Institut Lumière Matière, Université Claude Bernard Lyon 1, CNRS, UMR 5306, France

³ Université Paris-Saclay, CEA, LIST, Laboratoire National Henri Becquerel, France

⁴ Institut Universitaire de France (IUF)

*Presenting and corresponding author – E-mail: yannis.cheref@ens-lyon.fr

INTRODUCTION

The measurement of pure β emitting radioactive gases such as ^3H and ^{85}Kr is already of major importance for the nuclear safety authorities, and will meet an increasing demand with the expansion of nuclear-based energy production. Due to the short penetration length of β electrons in air, gaseous β emitters must be mixed with radiosensitive elements to enable detection. These are either gas-gas mixtures in an ionization chamber, or gas-liquid mixtures in liquid scintillation. However, none of these existing methods combine real-time analysis, sensitivity to multiple gases, and ease of deployment for on-site measurements. We demonstrate a new gas-solid mixture approach using inorganic aerogels as nanoporous scintillators.

EXPERIMENTAL STUDY

This presentation will focus on the preparation of scintillating aerogels. Scintillating nanoparticles were synthesized in the 10g-scale via a solvothermal route. After extensive washing, a controlled aggregation procedure allowed for their assembly into gels. These gels were then dried into transparent aerogels in supercritical CO_2 . The aerogels were then exposed to known quantities of radioactive gases and their scintillation was measured. The procedure was initially developed to produce $\text{Ce}^{4+}:\text{YAG}$ nanoparticles aerogels, and was subsequently applied to other scintillating nanomaterials.

RESULTS AND DISCUSSION

Transparent scintillating aerogels were obtained by the same method for $\text{Ce}^{4+}:\text{YAG}$ (Fig. 1) and other nanomaterials. Statistical treatment of their measured scintillation allowed efficient, real-time measurement of ^3H and ^{85}Kr activity.



Fig. 1 - Aerogels before (left, $\text{Ce}^{3+}:\text{YAG}$, yellow sample) and after (right, $\text{Ce}^{4+}:\text{YAG}$, white sample) thermal treatment

CONCLUSION

We demonstrate a new gas-solid mixture approach using inorganic aerogels as nanoporous scintillators. This method combines the above criteria, allowing efficient real-time measurement of ^3H and ^{85}Kr activity.

ACKNOWLEDGMENTS

The authors acknowledge support from the European Community through grant n° 899293, HORIZON 2020 – SPARTE.