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► To cite this version:

Irene Munoz Velasco, Sonia de Sousa Nobre, Olivier Renard, Sebastien Garcia-Argote, Pierre Colonna, et al.. Potential of radioluminescence for phototherapy in the treatment of Parkinson's disease. SCINT 2024 - 17th International Conference on Scintillating Materials and their Applications, Jul 2024, Milan, Italy. cea-04889877

HAL Id: cea-04889877

<https://cea.hal.science/cea-04889877v1>

Submitted on 15 Jan 2025

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Potential of radioluminescence for phototherapy in the treatment of Parkinson's disease

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Photobiomodulation is a promising technique aiming at slowing down neurodegeneration by illuminating a specific brain region depending on the neurodegenerative disease. Clinatec is currently conducting the first clinical trial with 4 patients, suffering from Parkinson's disease, implanted with an intracerebral optical fiber emitting light at 670 nm wavelength [1].

In this context, a RadioLuminescent (RL) device based on luminescent materials excited by the beta-decay of tritium is of high interest by being less invasive, proposing potentially more efficient light delivery to tissue due to its compactness and ability to produce diffuse light, and with greater energy autonomy for patient comfort.

Several strategies for coupling tritium with luminescent materials are documented, including the use of tritium-gas [2], tritiated water [3] or a solid tritiated matrix [4,5].

In this presentation, we will show quantitative results on the development of a millimeter-sized RL device in which tritium beta-decay excites luminescent materials. The adopted strategy is based on an organic matrix serving as both tritium and luminescent material reservoir. Cylindrical samples made of either silica or cellulose aerogels have been fabricated and characterized. For light emission, red-emitting luminophores and quantum dots such as Y₂O₃:Eu, YVO₄:Eu and AgInS₂ have been selected and their optical properties characterized using photoluminescence, cathodoluminescence, quantum yield measurements, x-rays tomography and BET surface area analysis. Samples were placed within an integrating sphere and exposed to tritium-gas atmosphere (from 0.2 to 1.2 bars), allowing us to quantify their optical performance while varying the tritium pressure. Our findings suggest a direct dependence between the optical power and tritium pressure as well as a potential mechanism for trapping tritium atoms in micrometer-sized luminescent materials. On top of that, we could correlate the brightness to the concentration and material composition. This ongoing work holds promise for developing self-powered luminescent devices for optimized phototherapy in clinical applications.

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