Solvent-free liquid scintillator: a breakthrough discovery in liquid scintillation

Pauline Vergnory[1], Guillaume H.V. Bertrand[1], Victor Buridon[1]

[1] *Université Paris Saclay, CEA, List, F-91120 PALAISEAU, France*
Corresponding Author Email: pauline.vergnory@cea.fr

Numerous domains of application such as nuclear research, ionizing radiation detection, and CBRN-e security use and need liquid scintillators. These materials are composed of one organic solvent, most commonly toluene, xylene, or more recently diisopropylnaphthalene or phenylxylylethane, combined with one or multiple fluorophores such as diphenyloxazole, anthracene or 1,4-bis(5-phényloxazol-2-yl) benzene.
Compared with plastic scintillators, these offer superior lifetime, lower impurity levels, and better neutron/gamma discrimination [1,2]. However, the use of solvent matrix in liquid scintillators leads to chemical instability, high flammability and volatility, and a low flash point [3]. For safety and environmental reasons, their use requires small and sealed volumes.

Our recent developments overcome these problems, using an innovative patented material: a eutectic system [4] which is a solvent-free molecular mixture, melting at a temperature lower than that of each component. Eutectic mixtures are characterized by high thermal stability and low vapor pressure.
The organic molecules used in these developments are the one commonly used in liquid scintillation, making it possible to obtain a solvent-free liquid scintillator with good thermal stability, low flammability and volatility.

Currently, a large panel of Liquid Eutectic Organic Scintillators (LEOS), with melting points ranging from 16 °C to below 4 °C, depending on components and their relative proportions, are studied and will be presented. Four or more primary fluorophores, in which have been added secondary fluorophores to increase neutron/gamma discrimination and scintillation yield, compose them. Those LEOS have a scintillation yield reaching 9700 ph/MeV and neutron/gamma discrimination performance of 2.4 in FoM. This demonstrates capabilities comparable to commercial standard, achieving 70 % of the performance of BC501A for eight times less volume. These results are reproductible even after multiple low-temperature phase transition cycles.

This breakthrough discovery could enable the production of large volumes of liquid scintillators, ensuring improved protection for both workers and the environment. These first results demonstrate the richness of this new family of liquid scintillators without any traditional flammable or volatile solvent that open the door to new applications in several fields. Additional studies could highlight the potential use of LEOS at high temperature without risk, and their doping potential.

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