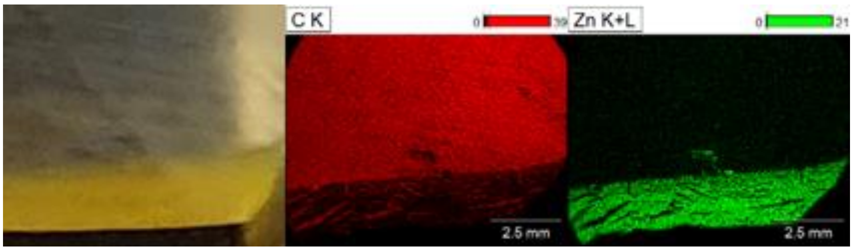
Outline Agenda
NuSec Lunchtime Online Seminar 28th July 2021, 1-2pm

1.00pm Introductions – Dr Neil Gaspar, AWE

1.05pm Talk Title: X-ray Luminescence of CuInS/ZnS Quantum Dot Loaded Plastic Scintillators



Summary: Exciton confinement within nanoparticle quantum dots (QDs) can result in electrical and optical properties that are not exhibited within bulk material of the same composition. This talk reports how loading CuInS/ZnS QDs in a polyvinyl toluene (PVT)-based plastic scintillator redshifts peak wavelength and alters emission intensity. Several quantum dot materials were dispersed within toluene and characterised, with CuInS/ZnS selected for loading into plastic scintillator since it produced the brightest emission and had a 180±1 nm Stokes shift large enough for negligible self-absorption.

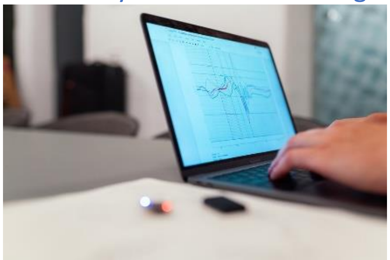
Three QD loading regimes within cubic plastic scintillator were adopted: homogenous, highly loaded layer at one edge and a hybrid between the two. QD loading was characterised through energy-dispersive X-ray spectroscopy. Comparisons between QD-loaded and unloaded scintillators were assessed through photo and X-ray induced luminescence. Photoluminescence from unloaded plastic scintillator showed peaks at 425 nm and 440 nm; the inclusion of CuInS/ZnS QDs resulted in an additional luminescence peak at 550 nm. X-ray luminescence of QD-doped plastic scintillator exhibited the same peak wavelength shift. The homogeneously loaded plastics were dimmest while scintillators with highly loaded layers produced more intense emission than unloaded plastic. This is attributed to the increased X-ray stopping power of CuInS/ZnS compared to plastic scintillators.

Presenter: Callum Grove

Bio: A postgraduate researcher in the Radiation and Medical Physics group at the University of Surrey investigating quantum dot loaded scintillators for use in radiation detection. Previously completed an MPhys at the University of Surrey that included a yearlong research placement at AWE, which focused on portable radiation detectors for muon scattering tomography for the Alternative Signatures team within the Nuclear Threat Reduction programme.

1.20pm Questions and Discussion

1.30pm Talk title: Mathematical and Computational Models for Simulating Transient Nuclear Criticality Excursions within Fissile Powder Systems with Fluid Ingress



Summary: A phenomenologically based integrated physics methodology for the analysis of nuclear criticality excursions in fissile powder beds under fluid ingress conditions is presented. The ingress of fluids (e.g., water) into fissile powder beds can lead to a number of rheologically different systems such as cakes, sludges, slurries, emulsions, colloids and suspensions, depending upon the specific constituents of the powder bed and the fluid that ingresses into the system. These rheologically different systems are often found in the front and back-end of the nuclear fuel cycle and in certain scenarios may lead to inadvertent, unexpected and uncontrollable nuclear criticality excursions. The standard approach to nuclear criticality safety assessment is to assume some prescribed sub-critical packaging limits to avoid and eliminate the possibility of any inadvertent nuclear criticality excursion within a system through engineered approaches. The aim of the research is to demonstrate an alternative approach, to nuclear criticality safety assessment, which is to quantify the consequences of such inadvertent nuclear criticality excursions as well as develop appropriate emergency planning and preparedness methodologies that could help mitigate the consequences of such inadvertent nuclear criticality excursion. The approach taken is to develop phenomenologically based, integrated physics, models of the phenomena including models for the neutron kinetics, water infiltration and nuclear thermal-hydraulic feedback effects including boiling, steam and radiolytic gas production. It is hoped that the development of such integrated physics models may lead to future improvements in mitigating such accidents through appropriate modifications, and enhancements, to pre-existing emergency planning and preparedness methodologies.

Presenter: Greg Jones

Bio: PhD researcher in the Nuclear Engineering department at Imperial College London. Research focuses on nuclear criticality safety in fissile powder-based systems by developing time and space-dependent phenomenological models. Previously received a Master's in mechanical engineering from Loughborough University with a dissertation in the field of Computational Linguistics.

1.50pm Questions and Discussion