A High-Throughput Technique for Screening the Light Yield in Doped Rare-Earth Inorganic Scintillator Coatings

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Scintillators in X-ray imaging systems convert incident X-ray radiation into visible light, enabling the generation of digital images for applications in medical diagnostics, aerospace and security screening. X-rays transmitted through an object strike a scintillator, where they are absorbed and converted into visible photons. This visible light is then detected by a photodetector and processed to generate a digital image. Scintillator performance in X-ray imaging is strongly influenced by light yield. However, for many inorganic scintillators the light yield is sub-optimal. Increasing the light yield would enhance image resolution and improve contrast for greater detection efficiency, allowing lower X-ray intensity exposure and therefore improving scintillator and imaging performance.

This work presents the development of a high-throughput technique for screening a library of printed candidate X-ray scintillator powder materials, consisting of doped Lu_2O_3:Eu powders made at UCL. The high-density powders offered high X-ray absorption power to enhance detection efficiency compared to lower density elements. The candidate scintillator samples, along with a commercial benchmark powder, were processed as a doctor bladed high solid-loading ink (ca. 90 wt%) onto Mylar sheet or Tantalum foil (thickness of 150 µm) and dried in air and cut into 15 mm diameter disks.

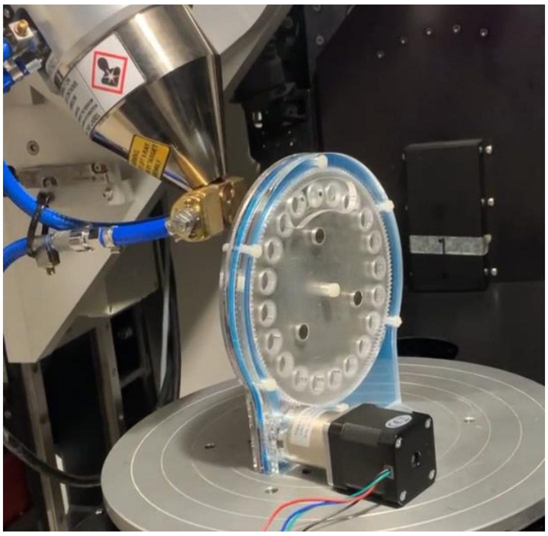

Figure 1*. Image of the custom carousel sample holder with the rotation mechanism in front of the X-ray source, showcasing the sample disk positions for imaging.*

To assess the samples which might be suitable for X-ray scintillation applications, the candidate disk samples and the commercial benchmark powder were placed in a custom built, vertical rotating carousel with an integrated X-ray blocking front plate for sample isolation from peripheral X-rays (developed at the University of Southampton by Mark Mavrogordato), and introduced one at a time into a collimated X-ray beam set-up, incorporating an X-ray source, mirror and a Complementary Metal Oxide Semiconductor (CMOS) camera to capture a spatially resolved grayscale intensity image (**Figure 1**). The images were collated together using ImageJ software and a customised Python script to elucidate a brightness map of the sample library, where conversion to CIELAB colour space provided the lightness (L*) channel data as a measure of relative brightness used to identify the candidates with the highest light yield.

In closing, the capability of this high-throughput imaging technique has been demonstrated using a series of doped lutetium-based phosphors and has identified a number of champion brightest doped sample compositions that will be scaled up and further optimised for next-generation scintillator applications.