LiveX – A dual field of view detector for synchrotron studies of metal solidification

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Aluminum manufacturing is directly responsible for approximately 2% of global CO2 emissions, and increasing the recycling rate is urgently needed to accelerate the decarbonization of the sector and meet the 2050 net zero target. The LiveX detector is a scintillator-based detector designed by STFC and the University of Oxford. The system was designed for use at synchrotrons to directly observe and study the solidification of various aluminum alloys to understand the role of processing conditions on the alloy microstructure. The data from the detector is directly fed into an AI model to classify the output in soft real time.

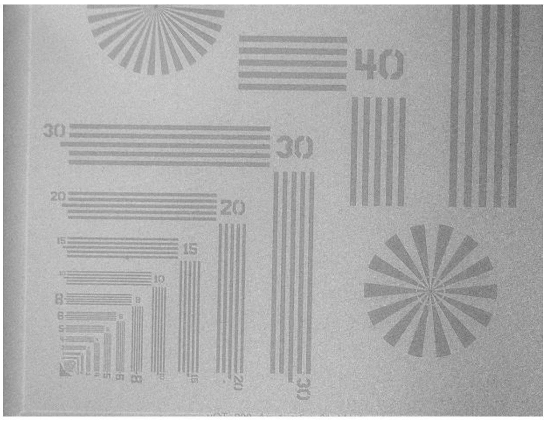

Figure 1: X-ray test chart at I13-2 at Diamond, under pink beam conditions using the narrow field of view system. Numbers correspond to line widths in µm.

The primary requirement was to be able to simultaneously resolve crystallites forming from the melt whilst also observing the entire sample. This resulted in a need to be able to resolve features as small as 10 µm whilst also having a field of view of 8 mm x 4 mm. This necessitated the use of relay lenses and a beamsplitter to split the light from the scintillators into 2 Orca Quest qCMOS cameras using both with microscope optics to enable high resolution imaging. Figure 2 shows a radiograph of a test chart showing line pairs with the line widths in µm with 10 µm clearly resolvable.

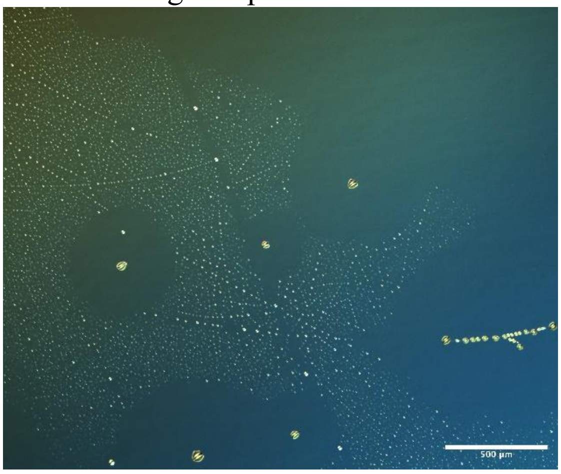

Figure 2: C-DIC micrograph of LuAG:Ce immediately after 12 hours at I13-2 at Diamond Light source. The diffraction like pattern and tracks were only visible for 24 hours.

We present our simulation, testing and validation of the lenses and optics, along with observation of radiation damage in dielectric mirrors resulting in electron-track like surface pitting from intense X-ray beams. We present testing of a range of scintillators and unusual types of transient radiation damage observed in LuAG:Ce (figure 2).

We also present plans on the next iteration of this detector with ambitions to enable higher resolution imaging through dynamic changing of objectives during experiments.

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