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Accelerated Ageing Through Thermal Cycling of Optical Coupling Samples to Investigate Performance Degradation in Detectors

Thermal cycling is used to accelerate the ageing process through an exaggerated version of the diurnal temperature variations that a detector or material may experience, during use or storage, over the lifetime of a detector. This is done in order to understand the potential causes of performance degradation or required frequency for recalibration. For this investigation, samples of the Eljen EJ550 optical grease were thermally cycled between +5 and +75℃ in an environmental chamber, with the relative humidity set to the minimum at each stage in the cycle such that the only degradation would be as a result of migration of material or thermal cycling. Four sets of samples were created with different preparation methods, volumes and substrates utilised in the preparation of optical grease samples, consisting of 0.02g between microscope slides, 2ml petri dish, and 1 and 2 inch diameter discs in petri slides. A total of 15 samples per set were created that were divided into three subsets: Cyclical, Duration and Room samples.
The transmission for all samples was measured using a spectrophotometer for a wavelength range of 300 to 700nm in order to cover the emission range of EJ200 scintillators. Identical samples with air as opposed to grease were utilised for baseline/zero corrections performed for the spectrophotometer, meaning all transmission values are relative to air. Cyclical samples were recharacterised at the end of each year equivalent cycle, Duration and Room were only recharacterised after the final cycle as controls for the removal from the chamber and the passage of real time respectively. Samples were cycled to equivalent of a maximum 20 years, with an additional set of "no bubble"samples introduced at the start of the 11th year equivalent cycle in order to determine the impact of the presence of air bubbles on the transmission. To aid understanding of the migration of material in real time, additional samples were created and positioned above a web camera set to capture images at regular intervals. The 1 inch petri slide samples displayed the greatest average variation in percentage transmission across the range 400-500nm, with a drop of 20% between pre and post-20 year characterisation (28% percentage difference), while the 2 inch petri slide samples showed an average 10% decrease in percentage transmission (15% percentage difference). Microscope slides and petri dish samples displayed a 2.6% average transmission decrease (3% percentage difference) and 3.9% average transmission increase (4.7% percentage difference) respectively.

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