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PALS –Setup optimisation and application to macromolecular materials characterisation

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One of the fundamental structural aspects in soft condensed matter is the free volume, which include atomic defects, vacancies, pores and voids, which exists in the interior of matter, due to irregular packing, density fluctuations and topological constrains. The free volume is considered as the volume fraction enabling molecular reorganisation and is of fundamental importance in influencing a material's physical, chemical and mechanical properties.

Positron annihilation lifetime spectroscopy (PALS) is a non-destructive spectroscopy technique that enables a complete study of the free volume structure in materials, especially regarding the existence, dimension and concentration of these free volumes. PALS is based on the measurement of the elapsed time between the implantation of positrons into the material and the emission of the radiation resultant from the positron-electron annihilations. The lifetime of positrons is different for the ones which annihilate in the bulk of the material and the ones which annihilate in its free volumes. Therefore, the lifetime of the positron can then be used to determine the free volume size and concentration of the sample.

Then, this work aims at the experimental optimisation of a PALS spectrometer, with a subsequent application of this tuned experimental setup to the characterisation of macromolecular materials, namely radiation processed polymer-based and hybrid materials for biomedical applications and for the consolidation of stone-based materials.

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